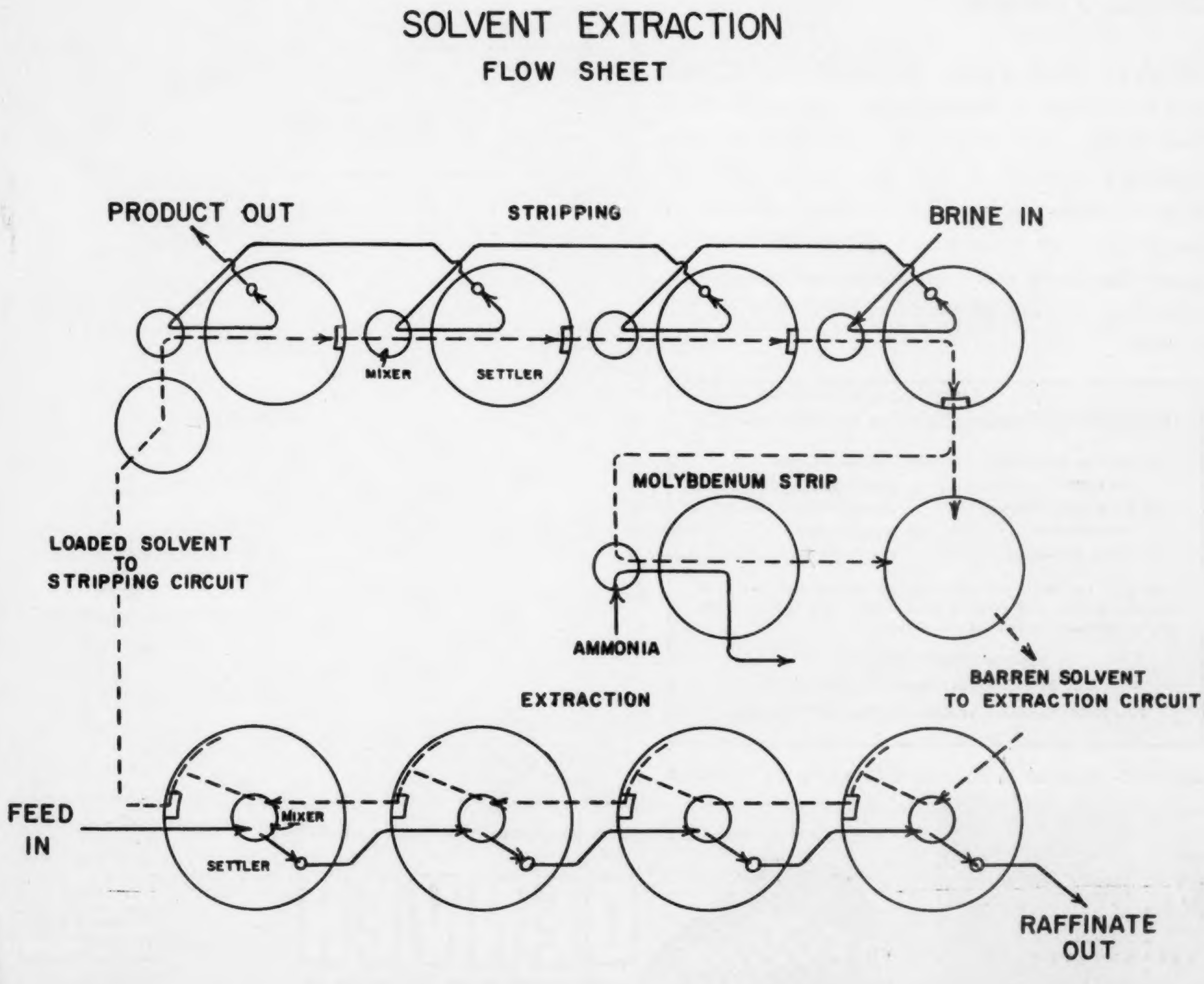
MINING CONGRESS JOURNAL

AMC

JULY 1960



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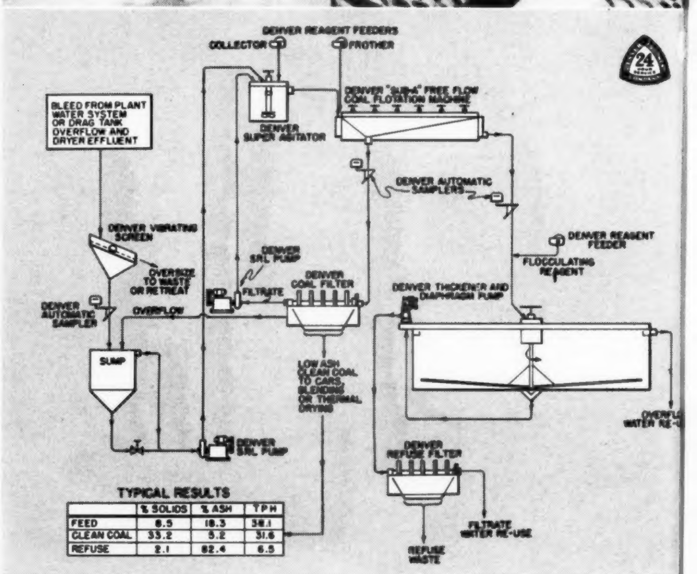

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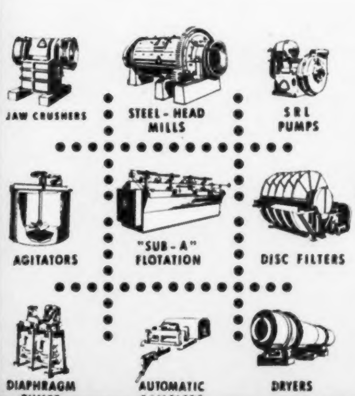

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MINING CONGRESS JOURNAL

VOL. 46 JULY 1960 NO. 7

CONTENTS

Opinions expressed by the authors within these pages are their own and do not necessarily represent those of the American Mining Congress.

ARTICLES

DEPARTMENTS

ON OUR COVER

Flow sheet of Kermac Nuclear Fuels Corporation's solvent extraction plant in the Ambrosia Lake District, N. M. For complete details see p. 56 to 59.

Published Monthly. Yearly subscriptions, United States, Canada, Central and South America, $3.00. Foreign, $10.00. Single copies, $0.75. February Annual Review Issue, $1.25. Second class postage paid at Washington, D. C., and at additional Post Office, Lancaster, Pennsylvania.

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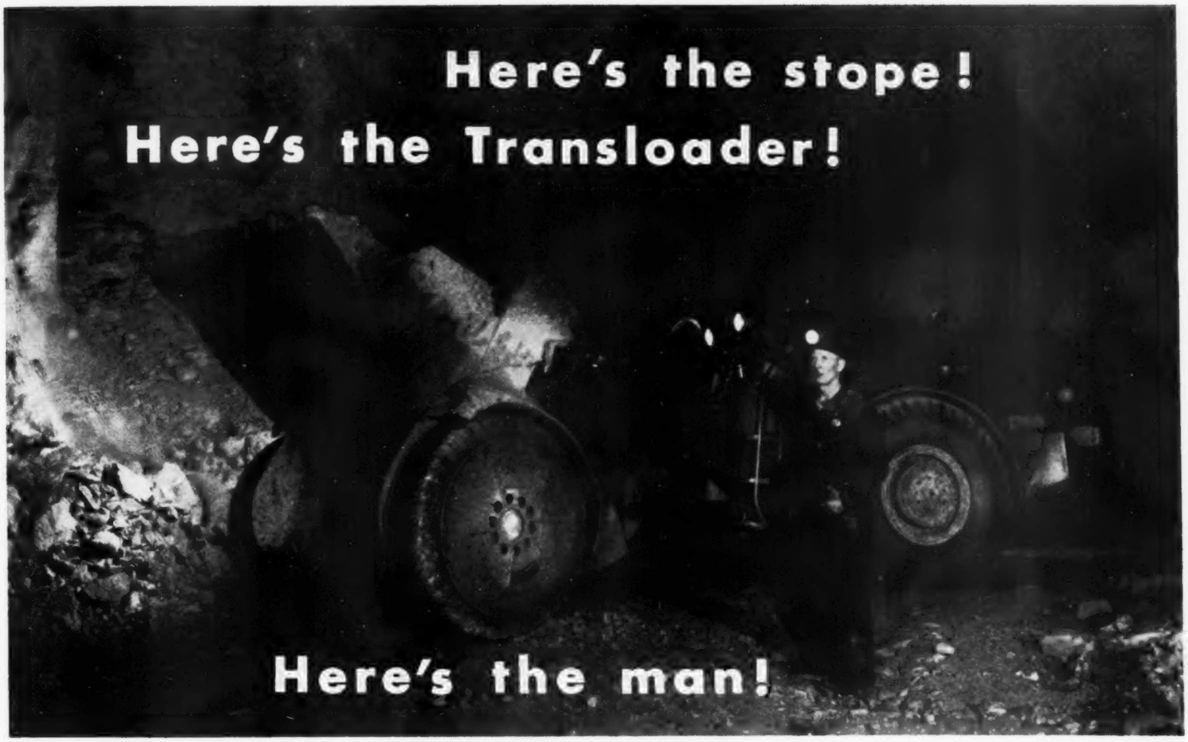

THE FACTS ARE, FURTHER, that the S-D Transloader requires (1) the *lowest* original cost for tons handled . . . (2) *lowest* maintenance, due principally to extremely simple design . . . (3) *least* ventilation due to low horsepower to work done . . . and (4) *lowest* labor cost per ton!

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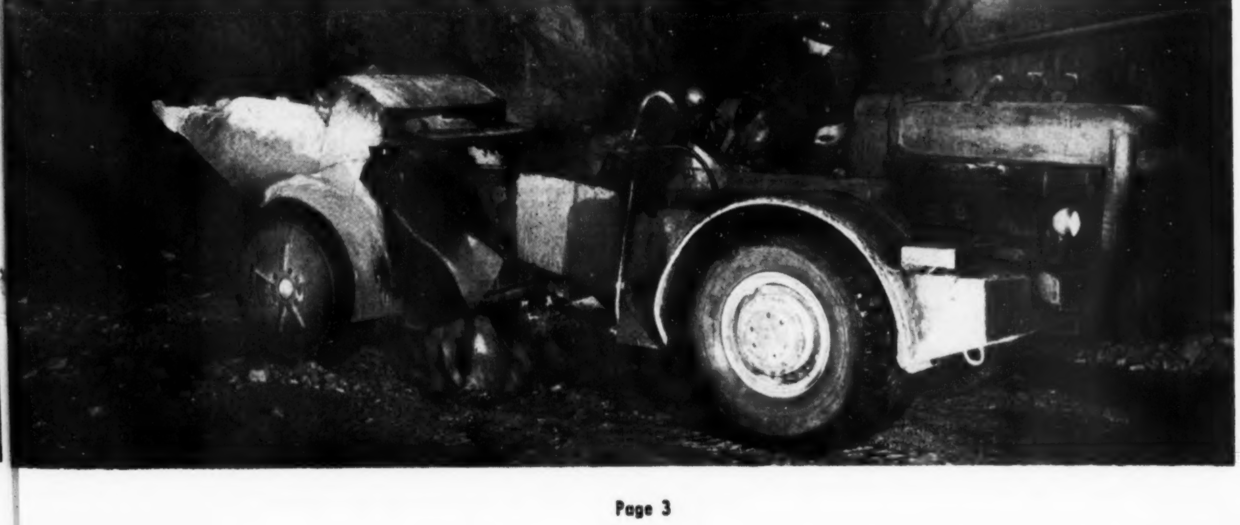

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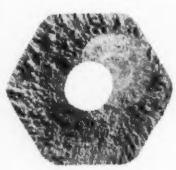

Appearance of a fatigue breakage that often arises with rods that have not been protected against corrosion. Sandvik's SR-treatment* protects against such failures.

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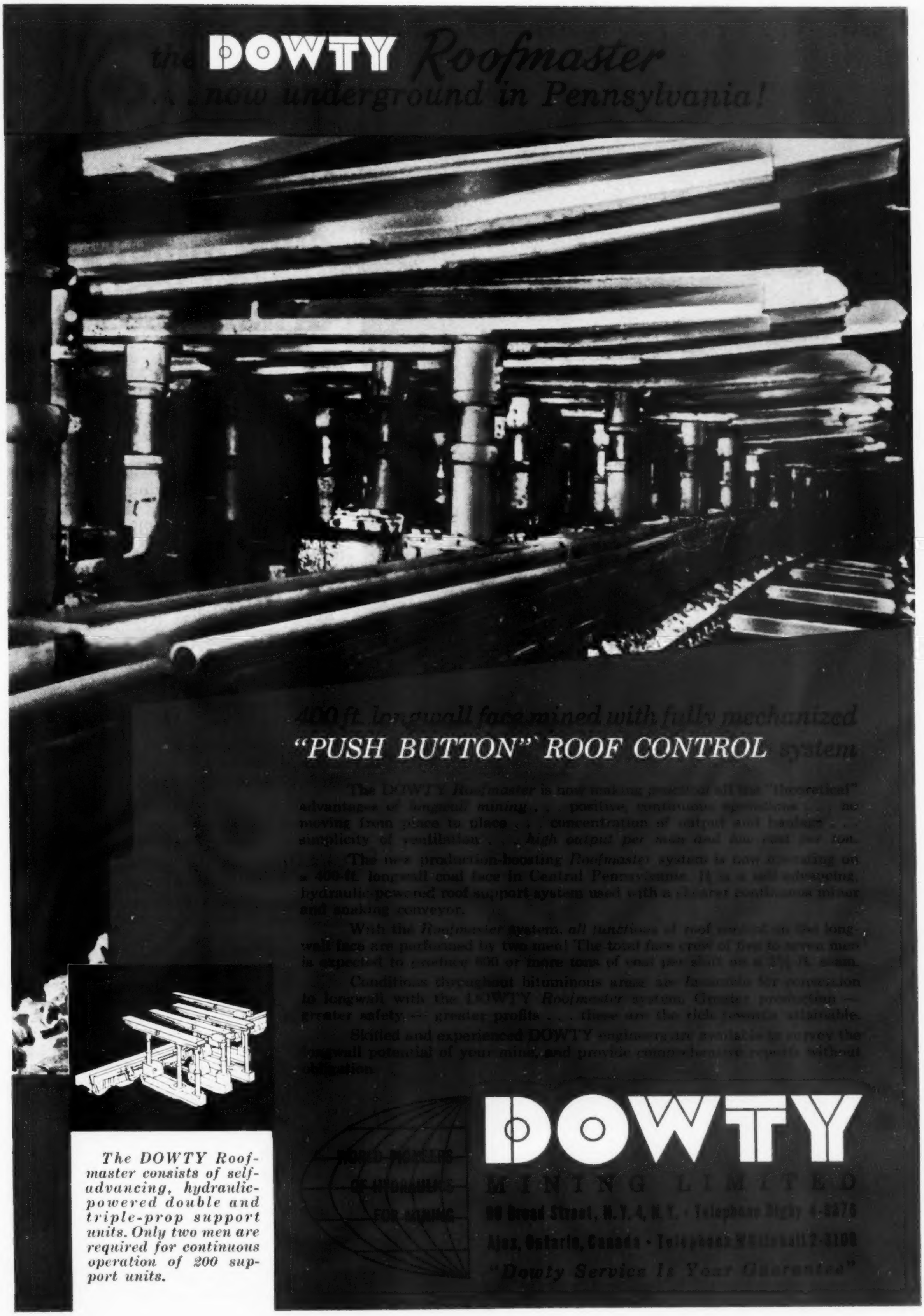

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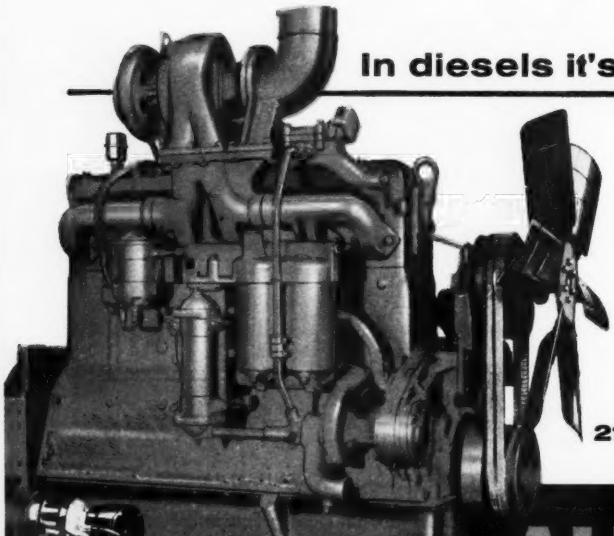
Displacement, Cu In	138	149	226
Maximum horsepower (gasoline)	39@ 1800 rpm	45@ 2000 rpm	67@ 1800 rpm

POWER-CRATER is an Allis-Chalmers trademark

In diesels it's the PERFORMANCE PROVED 21000 and 16000



The amazing 21000 and 16000 diesels are exceeding expectations wherever they are used. The turbocharged 21000 uses *8 to 27 percent less fuel* than any other engine in its class — and has stamina to match! Torque is consistently high, acceleration is immediate. Starting is fast, too, even at sub-freezing temperatures and without starting aids. Find out more about these and other diesels in the Allis-Chalmers line — various models and sizes to 516 hp.

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BE-21

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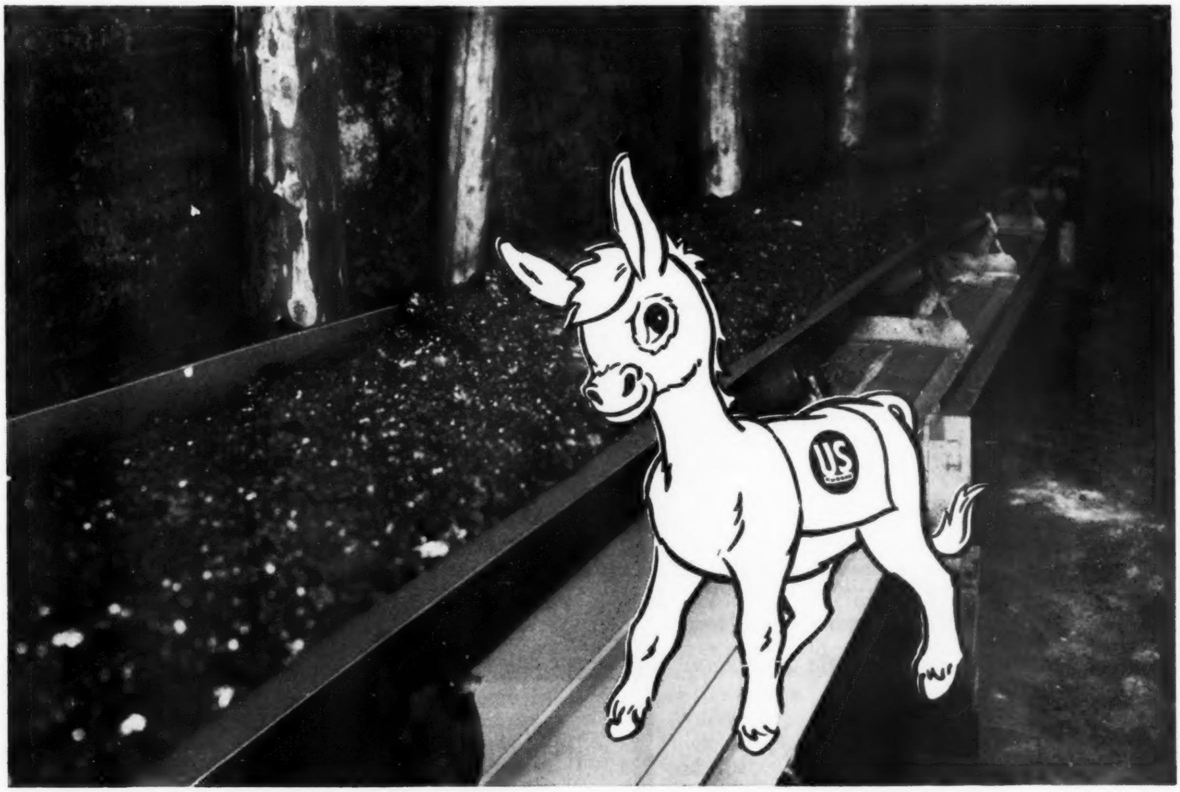

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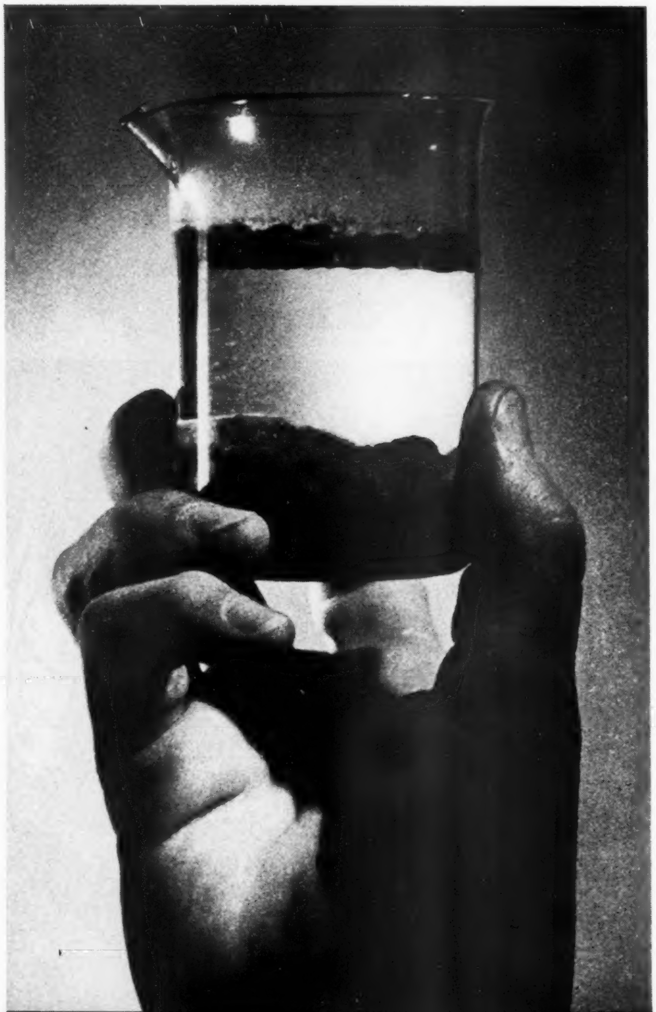

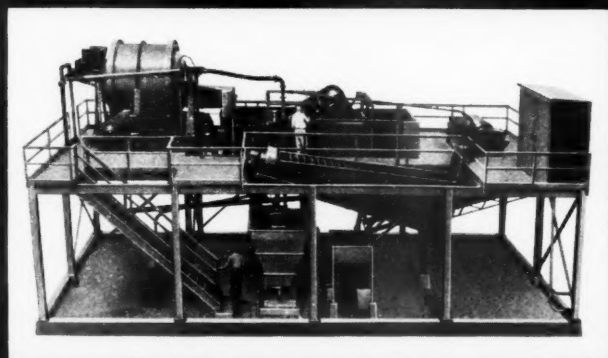

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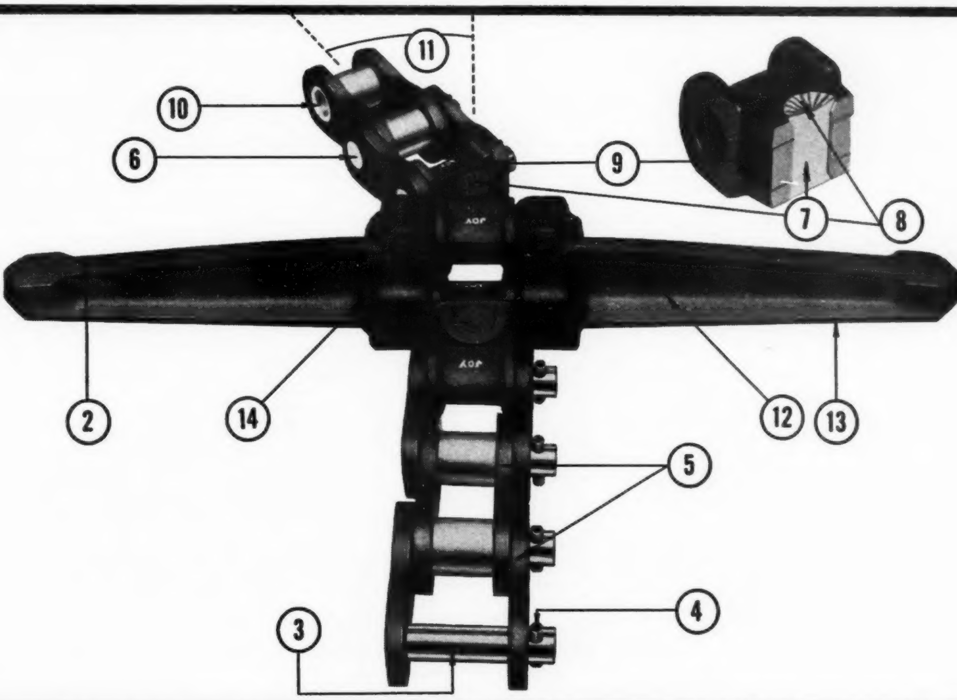
All new 2⅜" pitch chain fits all 24" Conveyor Machines



Your present loaders can be up-dated to give you new dependability with this new chain. It has larger dimensions, different geometry and different materials—different heat-treating techniques. Each of the parts were developed from our experience with the many different chains in our line. The best features of field-proved chains were assembled into this new chain to modernize all 14-BU's and all other 24" conveyor machines to give you new freedom from breakage . . . less downtime than ever before.

Find out for yourself why this new Joy chain is so superior. Study the photo and the features, then call in your Joy engineer. He has complete details.

Only the New Joy 14-BU Conveyor Chain Has All These Outstanding Features:

Strongest Connecting Link on the Market
3. Rugged, large-diameter pins—twice as strong.
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Optional Models—only chain available in 2 models
Available with (1) straight flight design for maximum conveying ability or (2) low coal model with tapered flights.

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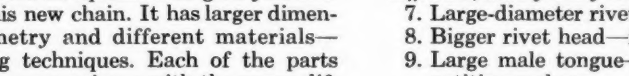

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EDITORIALS

The Rules of the Road for Percentage Depletion

Recent legislation, and a Supreme Court decision, have not answered all possible questions as to the computation of percentage depletion—but they have furnished broad general "rules of the road" which settle many of the disputed questions that have kept percentage depletion controversies in the public eye for the past several years.

In 1932, when Congress extended percentage depletion to coal, sulphur, and metal mines, the law did not spell out the "cut-off point" for computing the depletion deduction—merely specifying 5 percent, 23 percent, and 15 percent of the "gross income from the property." After extended discussion with representatives of the mining industry, the Treasury Department issued regulations which in effect recognized certain processes (such as cleaning and breaking of coal, concentrating of ores, etc.) as mining processes. Under these regulations, for example a lead-zinc producer could base his depletion on the selling price of lead and zinc concentrates (the "net smelter returns") but he could not base it on the selling price of the finished metal.

In 1943, after some controversy had arisen over the administration of these regulations, Congress in effect embodied the regulations and prior Treasury practices thereunder into the law—specifying the treatment processes includible as "mining" for the various classes of minerals then entitled to percentage depletion. In doing so, Congress also wrote into the law a provision to the effect that "mining" included the "ordinary treatment processes normally applied by mine owners or operators in order to obtain the commercially marketable mineral product or products."

While there were some difficult questions in the administration of the 1943 provision, for the most part the mining industry and the Treasury Department were able to resolve these difficulties for a number of years. In 1951 and 1954 percentage depletion was extended to practically all nonmetallic minerals, but without adding any specifications to the definition of "gross income from mining." The result was that many mineral producers were unable to determine with certainty where they stood under the definition, and the courts were called upon to settle a large number of controversies.

The lower courts over the past several years have been practically unanimous in interpreting the statute to mean that a producer of minerals—other than those specifically covered in the definition of "gross income from mining"—could compute his depletion deduction on the basis of the selling price of the finished product. For example, the courts held that clay producers could compute their depletion on the selling price of brick, and that producers of calcium carbonates, etc. used in making cement could compute depletion on the selling price of finished cement. The controversy spread to other minerals, with one iron ore producer claiming depletion on the selling price of pig iron, and a coal producer claiming depletion on the selling price of coke.

In 1958 the Treasury Department asked Congress for legislation cutting back from the courts' interpretation with respect to clay and cement, but Congress failed to act. In 1959, after it had become obvious that the controversy existed with respect to a large variety of minerals, the Treasury asked Congress for a completely new definition of "mining" as to all minerals. A primary feature of the Treasury's proposal was the elimination of the "commercially marketable" test.

After extended consideration, the Tax Committee of the American Mining Congress, through its chairman, Lincoln Arnold, told the House Ways and Means Committee in March 1959 that the AMC concurred in the elimination of the marketability test, in order that the percentage depletion concept may be continued on a sound and reasonable basis. In taking this position, the Mining Congress emphasized various important changes needed in the Treasury's proposed bill in order to continue the allowability of processes traditionally considered "mining" and the allowability of processes equivalent thereto, and administratively granted in the past, for the nonmetallic minerals.

The position of the AMC Tax Committee was not looked upon with favor by all members of the mining industry—a perfectly natural situation, because with the extremely high tax burden imposed upon our citizens it follows that taxpayers are loath to pay higher taxes than the law, as interpreted by the courts, requires. However, the far-sightedness of the position taken by the Mining Congress has been borne out by recent legislative and judicial developments.

Last month Senator Albert Gore (Dem., Tenn.) offered the 1959 Treasury Department proposal as an amendment to the corporate and excise tax rate extension bill, H.R. 12381. The Gore amendment was adopted by the Senate by a vote of 87–0. The House-Senate conferees did not accept *in toto* a substitute amendment suggested by the Mining Congress, but they did substantially rewrite the Gore amendment, eliminating some of the harmful language and incorporating a number of important provisions advocated by the industry's organization. As rewritten, the Gore amendment was adopted by the House on June 27 and by the Senate on June 28, and the bill was signed by the President on June 30.

The new definition of "mining," which is effective for taxable years beginning after 1960, eliminates the marketability test, and continues the allowability of all processes which were specifically listed in prior law. In addition, it makes it clear that the definition covers all minerals. It specifies that brick and tile clay producers can include in mining "crushing, grinding, and separating the mineral from waste, but not including any subsequent process." In the case of calcium carbonates and other minerals used in making cement, mining will include "all processes (other than pre-heating of the kiln feed) applied prior to the introduction of the kiln feed into the kiln, but not including any subsequent process."

On June 27, while the new law was in the final stages of adoption, the Supreme Court jolted taxpayers involved in "cut-off point" controversies with a legal "haymaker." Interpreting the law for past years (as previously stated, the new law is effective in 1961), the Supreme Court in *U.S.* v. *Cannelton Sewer Pipe Co.* ruled against the end-product philosophy of the lower

(*Continued on page 84*)

Factors Affecting the Choice Between CONTINUOUS MINERS and CONVENTIONAL EQUIPMENT

By W. F. DIAMOND
Manager of Engineering
Island Creek Coal Co.

Island Creek Coal Co., in re-equipping three mines, chose conventional equipment for two, and continuous mining equipment for the third

One of the prime advantages of continuous mining machines is that concentration can be readily attained

CONTINUOUS mining machines have been under development for a great many years, but they first began to make their appearance in

numbers in the coal industry about 1952. Since that time an ever larger percentage of the annual production of the industry has been turned out by machines of this type.

The increase in the use of continuous miners has resulted from the improvements in these machines evolved over the years and the promise they hold out for further reducing the element of production costs attributable to labor.

Conventional mining equipment has been on the scene much longer than have continuous miners, and much of the market lost by conven-

tional equipment has been absorbed by the miners. However, conventional equipment is not on the way out by any means, for while continuous miners have been gradually improved over the years, the manufacturers of conventional equipment have also been improving the performance and increasing the productive capacity of these units.

As a consequence, conventional equipment is still in the picture, and any decision involving the selection of production units for a new mine, or for the machines to re-equip an old mine, must include a study of the possibilities of using both types of equipment. In general, the information in this article will apply to seams of any mineable thickness in which the two types of equipment would be interchangeable.

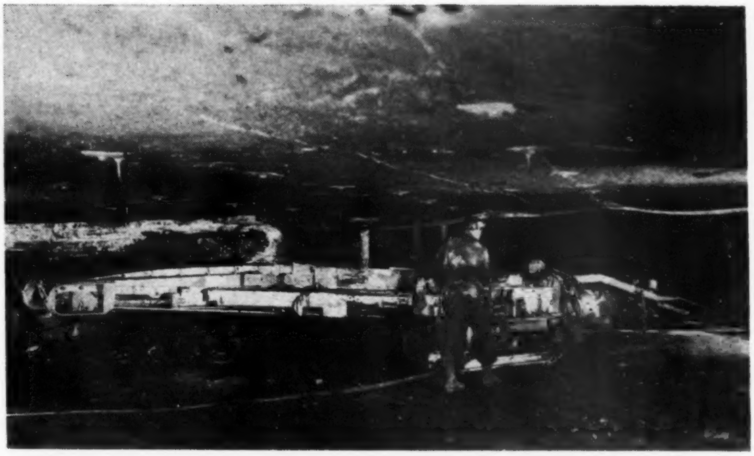
The choice of whether to use continuous miners or conventional equipment in a mine is naturally dependent upon the analysis of a great many factors, and this discussion will touch briefly on some of the more significant ones.

Certain of the factors will apply whether the mine is new or old, while others are particularly pertinent if the mine has already been partially or fully developed.

Study Adaptability of Available Machines

At the top of the list would be adaptability of the available machines to seam conditions throughout the area to be worked. Should the seam show considerable thickness variations or should heavy partings be present in some areas, but not others, the choice leans toward conventional equipment which can handle these situations with a minimum of difficulty.

Considerable variations in the makeup of the seam tend to favor conventional equipment over continuous miners for yet another reason. One of the prime advantages of continuous miners is the fact that concentration can be readily attained with this type equipment. Yet, considerable variations in the seam from area to area, in the same mine, may necessitate working simultaneously in several scattered locations in order to balance the raw feed to the preparation plant to yield some uniformity in clean coal output from month to month. Concentration of all mining in a thick parting area will result in a lower yield of clean coal per unit shift with a corresponding adverse effect on costs; but, in addition, an increase in down time and maintenance costs can be anticipated under these conditions, making full concentration impractical.



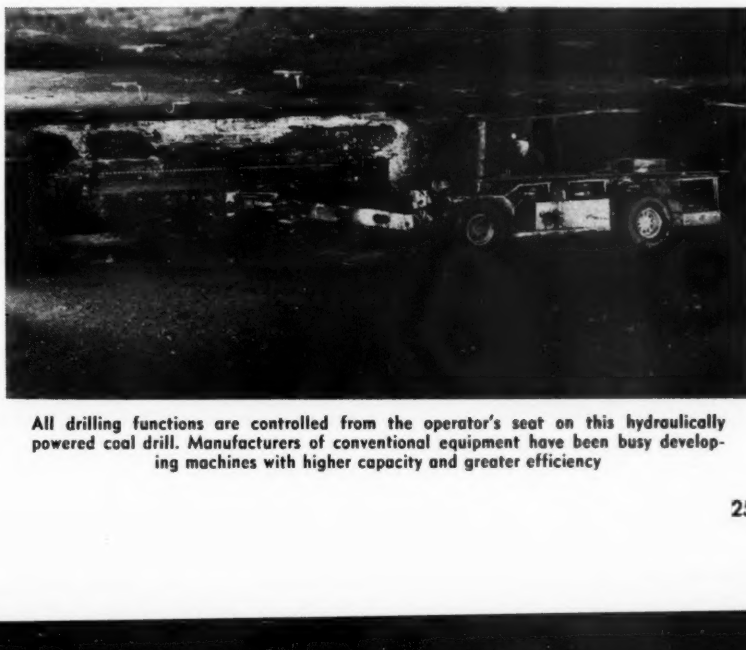
The choice leans toward conventional equipment in any seam that shows a considerable variation in thickness or has heavy partings in some areas but not in others

Anticipate Markets

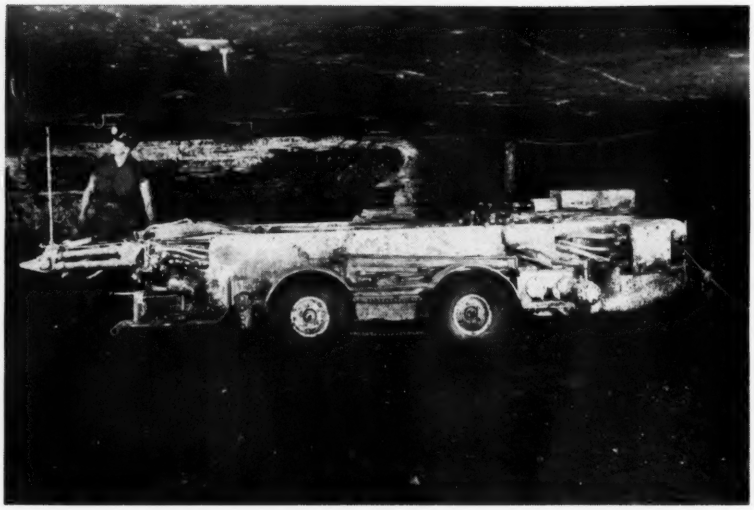
Another factor would be the anticipated markets to be served by the mine. While the domestic market has been gradually disappearing over the years, there is still a substantial tonnage moving to retail yards, and this, being a high realization market, is worth exploiting as long as it exists. Here again conditions might weight the choice in favor of conventional equipment.

Quite aside from the fact that a coarse product is desirable where domestic coals are in significant demand, a coarse raw product can be advantageous in coals going to other markets, especially if the ash content of the raw coal is such that separate cleaning of the fine and coarse coal with thermal drying of the fine coal is necessary, for it will be found that coarse coal cleaning capacity can be purchased at a much lower capital cost than can fine coal cleaning capacity. Of even more importance is the fact that the coarse coal cleaning plant can generally be operated at a lower cost per ton hour of throughput. This means that under these conditions continuous miners can be expected to add to both the capital costs and operating costs of the plant.

It would be well to point out that with an existing plant only part of the processing difficulty is attributable to the increase in smaller-sized coal as such. Of equal importance and a matter sometimes overlooked is the fact that the dust problem at the face, where miners are used, necessitates heavy spraying at the machine, which dampens the coal and increases the fine coal screening problem. If the



All drilling functions are controlled from the operator's seat on this hydraulically powered coal drill. Manufacturers of conventional equipment have been busy developing machines with higher capacity and greater efficiency



The hydraulically powered roof bolt drill, which also carries a hydraulically driven circular saw, collects drill cuttings through the drill steel. No equipment evaluation would be complete without an appraisal of the roof support problems

fine coal is removed ahead of the washing unit, dry, there will be a substantial increase in rideover which means more fines in the water circuit, more water clarification problems and more fine coal moisture problems.

Don't Overlook Haulage

The matter of haulage equipment should also be investigated. Generally, the same haulage system that served the conventional equipment will do for the continuous miner production, unless a mine car, track system were in use that utilized drop-bottom cars. If they are part of the system, a careful check should be made of the slope of the side sheets. Older cars will be found to have a slope between 35° and 37½°, and this is too flat for continuously mined coal. For trouble free dumping at the bin, this angle should not be less than 45°.

In addition to the items mentioned, no evaluation would be complete without an appraisal of the ventilation problems, the roof support problems, and what the reaction of the bottom would be with the alternative types of equipment available.

Having resolved these questions, it is then possible to begin projecting unit production rates and costs, and estimating the capital expenditures necessary to achieve these costs.

Study Costs

In the development of cost and production projections to be used in trying to decide between continuous miners and conventional equipment, due allowance should be made for the variations in production level between continuous miners on advance work and those on retreat work, variations which are insignificant with conventional equipment.

At this point, the writer is drawing on Island Creek Coal Company's experience with continuous miners; but this experience is confirmed by the production experience of a number of other companies who are operating these machines, and that is that miners on development in solid work will produce at a 20 percent to 25 percent lower rate than those extracting coal from rooms and pillars, and this tonnage will be produced at a higher maintenance cost.

This characteristic of the machines may not result in 20 to 25 percent less tonnage than is produced per shift from room and pillar work, for an increase in roof support problems —especially in pillar extraction— may offset part of the higher production rate attainable in retreat work. However, Island Creek's experience indicates that a miner will produce a substantially higher tonnage from room sections than from development sections.

In the matter of capital costs, as between continuous miner equipped sections and conventional equipped sections, it will be found, in general, that the equipment in use on the two types of sections will be the same except that the miner will replace the cutting machine and the coal drill.

Because the bulk of the miners available today do a very poor cleanup job, the use of a pickup loader will be necessary and, as a consequence, the miner equipped section will require a substantially higher capital investment than will the conventionally equipped section. Spare assemblies and parts for the miner will also be more costly, necessitating larger and more expensive inventories.

The smaller crews used with continuous miners can be expected to yield a higher tons per sectional man than can be attained with the conventionally equipped section, but the total tons per section shift may be less, necessitating more sections of continuous miner equipment for a given mine tonnage and adding further to capital requirements.

More emphasis than warranted may have been given to the factors which tend to favor conventional equipment over continuous miners, leaving the impression that continuous miners really have no place in the industry. This is certainly not true as attested to by the fact that, in 1959, 140 continuous mining machines were purchased by the industry, while the equipment manufacturers were able to sell only 95 mobile loading machines during the same period.

It would be a rare mine which had all of the conditions mentioned which would tend to discourage the use of continuous miners. The concentration which the use of miners normally makes possible, with the consequent reduction in over-all costs this concentration yields, will go far toward offsetting some of their disadvantages.

No choice of equipment can be made that will have all advantages and no disadvantages; and, as a consequence, the selection made must involve compromise. The final choice will depend upon the value those making the decision place upon the advantages they get and the disadvantages they must accept with the equipment finally selected.

A Practical Example

Recently Island Creek was faced with the necessity of making a choice of the production machines to be used in the re-equipping of two mines or, to be more factual, three mines. Because two of the mines were interconnected underground and shared, in part, a common haulage, drainage, ventilation and power supply system and the equipment could be readily interchanged between them, it was advantageous—from a standardiza-

tion standpoint—to treat the two as a single problem.

These two mines have similar seam conditions, except for height, which varies from 90 down to 48 in.; the coal is a hard bituminous with a rock band, which in one area approaches 15 in. or more in thickness; grades are mild with one or two minor exceptions; roof is readily controlled with bolting and line posts. Both mines contain substantial reserves of virgin coal, and both mines have similar preparation plants.

Based upon the company's previous experience with continuous miners and the reduction in tonnage that occurs on development work in a seam with similar conditions, it was decided that a combination of continuous miners and conventional equipment would probably yield the lowest operating cost. Accordingly, studies were concentrated in this direction.

One early decision that had to be made was whether the new equipment should be a-c powered or d-c powered. The fact that the mines were already equipped with a high voltage cable system to service their inside rectifiers, plus the favorable experience Island Creek had had with an a-c installation in another mine, quickly settled this problem in favor of a full a-c system.

Visits were then made to a number of operations working seams with conditions similar to Island Creek's own where both the latest in conventional equipment and continuous miners were being used, and what management observed was compared with its own experience with the miners and conventional equipment.

Concurrently an appraisal was made of what effect, if any, the continuous miners would have on the preparation plants and estimates were made of the capital cost of equipping the two mines with the necessary production units and sufficient spare units to provide for periodic overhauls of the various machines.

The company's analysis indicated that the miners would produce a higher tons per man at the face than the conventional equipment, but total section tonnage would be less, necessitating an extra section of equipment and two more operating crews to produce the desired total daily tonnage.

This extra section would add substantially to capital costs. Further capital money outlays were anticipated due to the necessity for providing changeout spares for both types of productive machines, plus a substantial increase in money tied up in inventory items, if both conventional and continuous type equipment were to be employed.

Two Mines Equipped With Conventional Units

The disadvantages of high capital costs, preparation plant problems and lack of adaptability to the variety of seam conditions with which the company would have to contend, limiting its ability to employ concentration — these, management felt, more than offset the advantage of slightly higher tons per sectional man and slightly lower sectional cost. As a consequence, Island Creek decided in favor of all conventional equipment. Both mines were equipped with identical units.

The equipment per section consists of a crawler-mounted loader with an 18 tpm peak loading rate; a rubber-tired Universal cutter equipped with an 11-ft bar and slack handling device; a self-propelled hydraulic-powered coal drill; a hydraulic-powered self-propelled roof bolt drill; two eight-ton capacity shuttle cars; a custom designed elevator; and a hydraulic-powered car spotter.

All equipment is 440 volt a-c powered. A 300-kva transformer services the sectional equipment through two safety circuit centers; one near the loading point having five outlets and providing taps for the car spotter, elevator, two shuttle cars, and a spare. A second safety circuit center near the face services the loader, cutter, roof bolt drill and coal drill.

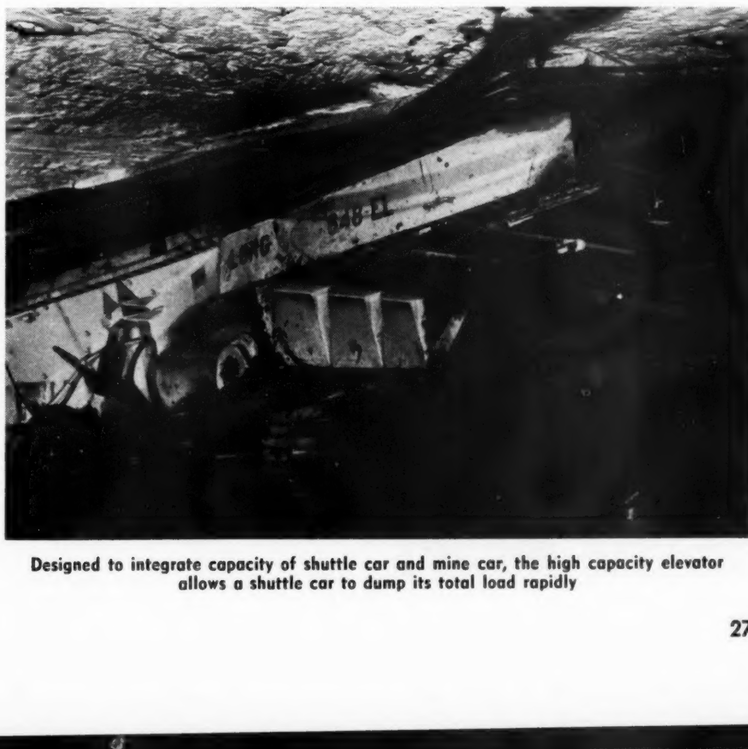
Conditions at Third Mine Favored Continuous Mining

Shortly before the time the study was made to determine what equipment should be purchased for the two mines described above, a similar study was made looking toward the selection of the machines to re-equip a third Island Creek mine which is extracting coal from the No. 4 Pocahontas seam.

The seam at this mine ranges in thickness from 66 to 90 in., has been fully developed on an 85-ft center block system and all future work will be devoted to pillar recovery.

In this instance, the softness of the coal; the absence of distinct hard rock partings; the presence of considerable weight on the pillars—the distinct advantage enjoyed by continuous miners in this type of mining where the work can be concentrated on one block at a time until it is completely extracted; and ability of the preparation plant to handle small-sized coal led to the decision to purchase miners for this operation.

Island Creek is confident that in both instances it has made the best selection for its particular conditions. The company has already exceeded the cost and production objectives established to justify the expenditures required to purchase the new machines; and management is confident that as the crews become even more proficient in the operation of the equipment, both mines will operate at a cost below and tonnage level well above original forecasts.



Designed to integrate capacity of shuttle car and mine car, the high capacity elevator allows a shuttle car to dump its total load rapidly

Slope stabilization in open pit mining

Instability of open pit mine slopes often results from excessive hydrostatic pressures behind the face; thus, adequate subsurface drainage is important

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IN the field of soil mechanics it has been found that most earth slides or slope failures are the result of excess water pressure accumulating behind the slope face. Recent experiences by the author have led him to the same conclusion with regard to the stability of cut slopes in open pit mines, particularly in fractured and fissured rock. It follows, then, that slope stabilization in open pit mines may be reduced to the basic problem of relieving excess water pressure by means of subsurface drainage. Unfortunately, this is as difficult in practical application as it is simple in concept. First, it must be verified that excess water pressure is present; second, the unique combinations of topography, stratification and faulting which collected the water and concentrated the seepage paths leading to the cut slope must be detected and analyzed, and third, a feasible and economical method of relieving the excess pressures must be devised.

Mechanics of a Slide

The simplest form of a slide is represented by a block resting on an inclined slope (figure 1, case I). The component of weight parallel to the slope tends to make the block slide downhill, and this force is resisted by friction between the block and the inclined surface. The frictional resistance, for most granular soils, is approximately proportional to the normal force. If the slope angle is increased, the driving force is increased, while at the same time the normal force, and therefore the frictional resistance, is decreased. When the driving force is equal to the resisting force we have a condition of equilibrium (factor of safety equal to unity), and any further increase in the driving force, or reduction in the friction force, will inevitably result in the block sliding down the slope. An actual example of this type of slide is shown in figure 2, and will be dis-

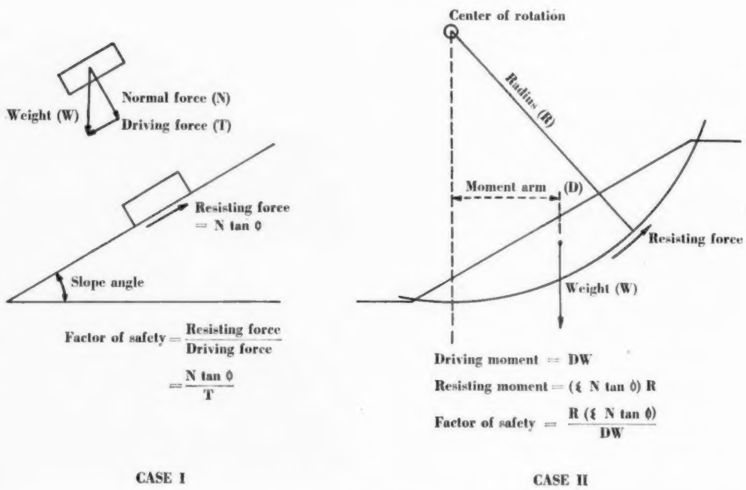


Fig. 1. Simplified slide analysis

cussed in detail in a later section of this article.

Usually, the failure of a slope occurs along a rupture surface closely approximated by a circular arc (figure 1, case II). In this case the mass of earth above the arc may be treated as a solid body with a weight W, tending to rotate about the center of curvature because of the clockwise moment DW. This rotation is resisted by the counter-clockwise moment exerted by the summation of friction along the surface of sliding multiplied by the radius R. An actual example of this type of slide is shown in figure 3.

In analyzing an existing slide, or in evaluating the stability of an existing slope, the magnitude of the driving force along any assumed plane or arc can be computed with reasonable certainty, since it depends only on the weight of the materials and the geometry of the slope. The resisting force, however, cannot always be evaluated precisely, since it depends not only upon the coefficient of friction, but upon still another variable, the uplift pressure of water along the slide plane.

Fig. 2. Slide zone in Pit A. In spite of an exceptionally mild winter and very dry summer there was an excessive amount of water in the fault zone below the slide. This flow increased markedly immediately after the slide, but then tended to dry up

Shear Strength of Granular Soils Independent of Particle Size

The shear strength of clean sands, gravels and broken rocks depends primarily on the following factors: 1) Normal stress between the contact surfaces, 2) Shape (but not actual size) of the individual particles, 3) Density or degree of compactness of the mass, and 4) Mineral constituents of the grains.

In general, the more compact the mass and the greater the angularity of the grains, the higher the shear strength of the mass. At any given density, and for similarly shaped grains, the shear strength is directly proportional to the normal pressure between the grains.

It is becoming to be generally accepted that the shear strength of granular soils is independent of the actual size of the individual particles. It is the author's conviction that the stability of cut slopes in fissured and broken rock can be analyzed by the principles of soil mechanics, because the scale of the pits is such that overall stability is independent of the size of the largest particles, regardless of whether these particles are several inches or several tens of feet in maximum dimension.

It is known from laboratory and field investigations that the angle of friction, corresponding approximately to the slope angle in excavation, varies from a minimum of about 32° or 33° for well rounded sand in loose state to something in excess of 45°

Figs. 3 and 4. Circular-arc slide (left) in open pit mine. Eyewitnesses reported large flows of water from the slope immediately after the failure. Circular-arc type of failure (right) in highway fill. The material which failed must have flowed almost as a fluid mass in contrast to the existing embankment which remained stable with almost vertical slope

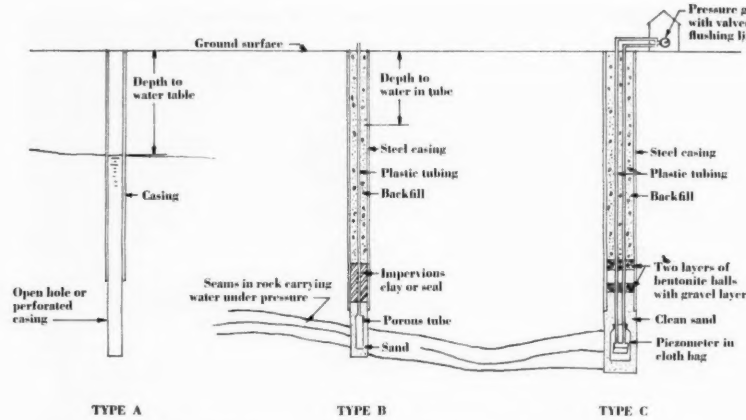


Fig. 5. Three types of piezometers for measuring uplift pressures

for compact angular crushed rock. Not only is the fissured rock in most open pit mines angular, it is in a compact state more dense than anything that can be developed in the laboratory. Therefore, it should be possible to excavate slopes as steep as 45° with reasonable expectation that such slopes would be stable, and in many instances this can be done. Often, however, these slopes will be found unstable at inclinations between 30° and 40°, and in a few instances, the author knows of slopes appreciably flatter than 30° that are in the process of sliding. The reason for this is based upon a well known principle of soil mechanics; the concept of *effective* stress as differentiated from *total* stress.

Effect of Uplift Pressures on Shear Strength

The shear resistance between two surfaces is proportional to the normal stress between the contacts. If there is water, other fluid, or even air along the zone of contact, the *effective* stress between the two surfaces is reduced by the pressure in the fluid (referred to as neutral stress). Since the shear strength is dependent upon the effective stress only, it is obvious that the presence of neutral stress, or uplift pressure, will decrease the effective stress and thereby the frictional resistance. An example of this is the loss of strength of a banana skin when loaded by a human foot. In this case the entire weight is transferred to pore pressure within the pulp, and the resulting shear strength is little more than that of the fluid itself.

Figure 4 shows a rather spectacular slide which illustrates quite graphically the result of uplift pressures. This was a highway fill of granitic sand, considered to be a non-cohesive granular material of excellent quality for embankments. However, the embankment had become saturated from springs in the foundation, and in January 1953 the culvert became plugged and a circular arc failure occurred suddenly. Notice how the material which failed must have flowed almost as a semi-fluid mass, in contrast to the existing embankment which remained stable with almost vertical slope. Compare figure 4 with figure 3, which developed in an open pit mine in Nevada. Eyewitnesses reported large flows of water from the slope immediately after the failure.

Piezometer and Slope Indicator Measurements

When a slope becomes unstable for any reason, the location of the critical circle or plane along which movement develops depends on many factors other than the slope inclination. Before any slide can be analyzed and corrective treatment initiated, it is necessary to determine both the position and shape of the zone of movement and the uplift pressures acting within this zone.

Uplift pressures are measured with piezometers. In the simplest form these may be observation wells (Type A) as shown in figure 5. A more sensitive type consists of a small diameter plastic tube connected to a porous stone embedded in sand, (Type B). A third (Type C) consists of a porous point connected with two plastic tubes (for flushing purposes) to a pressure gage.

Detection of the zone of movement is not so easily accomplished and even the best of diamond cores or undisturbed samples will seldom reveal the shear zone. In recent years the author has developed a so-called Slope Indicator (figure 6) which in a number of cases has been successful in delineating the zone of movement for extremely small movements.[1] It consists of a pendulum pivoted on ball bearings and enclosed in a water-tight brass cylinder about 2.5 in. OD and 15 in. long. The tip of the pendulum contacts a precision wound resistance coil and subdivides the coil into two resistances forming one-half of a conventional Wheatstone Bridge circuit; the other half, including switches and batteries, is enclosed in a control box at the ground surface. The inclination of the instrument is obtained from the dial reading of a precision potentiometer in the control box, which reads from zero to 1000.

In order to measure ground movements with the Slope Indicator, observation wells must first be installed.

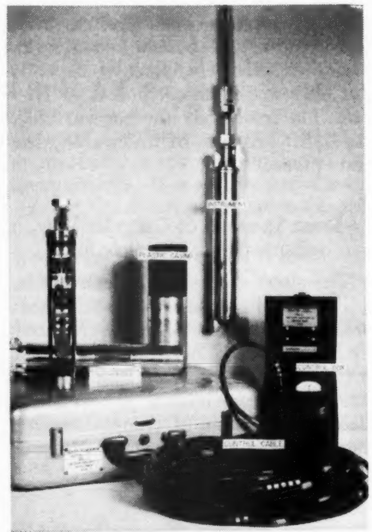


Fig. 6. Slope indicator and accessories

These consist of $2\frac{7}{8}$ in. ID extra heavy wall plastic casing which is extruded in five ft lengths, and in which four longitudinal slots are machined to guide the Slope Indicator. The casing is joined together at the job site with aluminum couplings which are cemented and crimped in place with the slots in the casing carefully aligned. After the plastic casing has been placed in the hole, with one pair of slots referenced in the desired direction, sand or grout is placed in the annular space between the plastic casing and the sides of the boring.

After the observation well is completed, the Slope Indicator is lowered into the casing with the wheels guided by the slots and dial readings are obtained at frequent (one to two

ft) intervals of depth in each of the four slots. The initial position of the casing is readily computed once the inclination (proportional to dial reading) is known. Subsequent readings which show the change in inclination are used to compute the change in position, or ground movement.

Slide at Pit A

Along the west face of the mine shown in figure 2 there are many faults, mostly exposed but some unexposed. Two of these faults intersect in the area under study. A number of old tunnels, stopes and underground mine workings have recently been found to exist beneath the upper portion of the slope.

Early in 1954, considerable difficulty was encountered in maintaining proper track surface and alignment through the fault zone from M to J levels. (See figure 8 for a longitudinal section). It was believed that a general increase in ground water through the years was a contributing factor to this difficulty. While a concentrated effort was made to strip back the slopes on all levels above M level, the critical need to develop additional ore resulted in steepening of the lower area (J to F).

On August 19, 1956 a slide occurred at approximately 7:15 p.m. from S down to O level. This slide developed very rapidly and gave little advance warning, although a small crack had been noticed at R level about noon. Also, a wet spot in O level had been noticed some days before the slide.

In spite of an exceptionally mild winter and a very dry summer there was an excessive amount of water in the fault zone below the slide (M to H levels). This flow increased markedly right after the slide but subsequently tended to dry up, and by the middle of September all the water was coming out on A level. Surveys made at this time showed movements of the order of four to eight in. per month between F and N levels. The average inclination of these movements was about 23°.

Establishing Shear Zone Location

In the fall and winter of 1957, five observation wells were installed in Pit A to provide information on the depth and rate of shear deformation both longitudinally and transversely of the slide, and also to act as piezometers for the purpose of obtaining information on hydrostatic stresses within the slide mass.

Figure 7 shows sections through

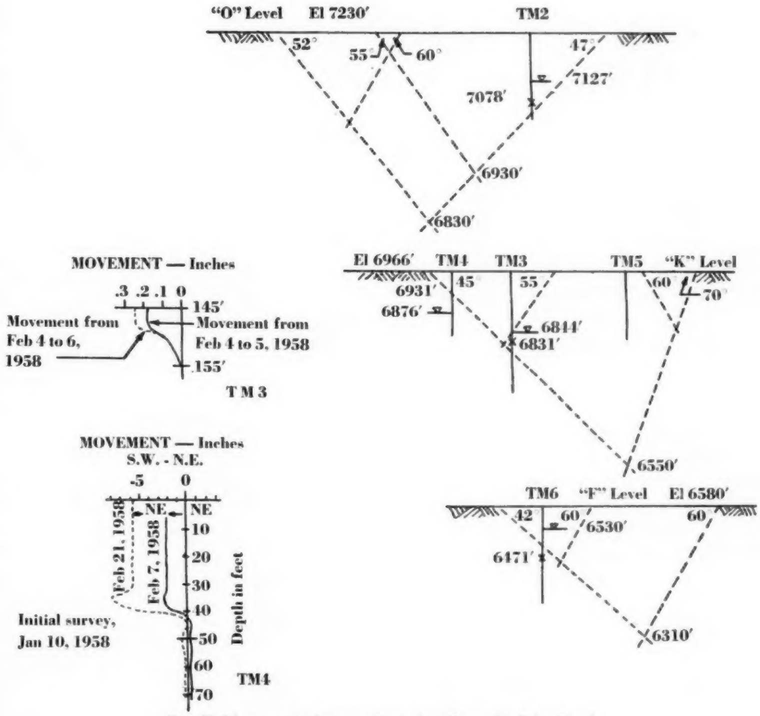


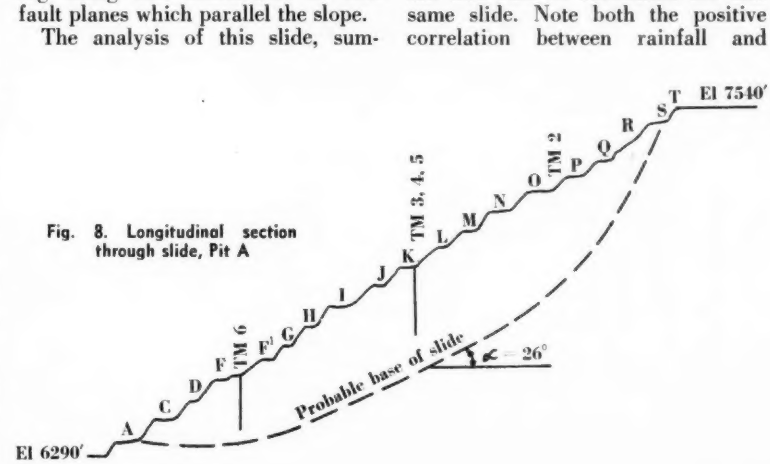
Fig. 7. Movement data and section through slide, Pit A

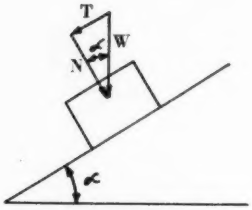
the slide at three locations, together with movement data, water levels, and location and dip of surface faults. The location of the sheer zone was established with the Slope Indicator as shown by the insets. Note that for TM3, the depth of movement was established the first day after installation of the casing, even though the movement in that period of time was approximately one-eighth in. Eventually, all casings were sheared off at depths indicated by crosses on figure 7. From this data the longitudinal section shown in figure 8 has been plotted. The slide is seen to be moving along the intersection of two fault planes which parallel the slope.

The analysis of this slide, summarized in figure 9, shows that for a factor of safety of unity and utilizing the measured uplift pressures (K equals 0.80), the angle of friction is approximately 36.5°, which is a reasonable value for gouge material found in the failure zones adjacent to the fault surfaces. In this case the friction angle is low because the slide developed in the gouge material, rather than through interlocking compact rock.

As further evidence of the influence of the uplift pressures on the stability of the slope, in figure 10 is plotted the relationship between rainfall and rate of movement for this same slide. Note both the positive correlation between rainfall and

Fig. 8. Longitudinal section through slide, Pit A



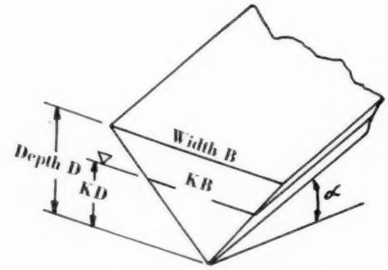


ASSUMPTIONS:

$\alpha = 26^\circ$

γ_s = Rock density = 162 lbs./cu. ft.

γ_w = 62.5 lbs./cu. ft.



TRIANGULAR SECTION

STABILITY COMPUTATION
(Based on unit length)

$$W = \frac{BD}{2}\gamma_s$$

$$N = W \cos\alpha$$

$$T = W \sin\alpha$$

$$U = \frac{BDK^2\gamma_w}{2\cos\alpha}$$

$$FS = \frac{(N-U)\tan\theta}{T} = (2-K^2)\tan\theta$$

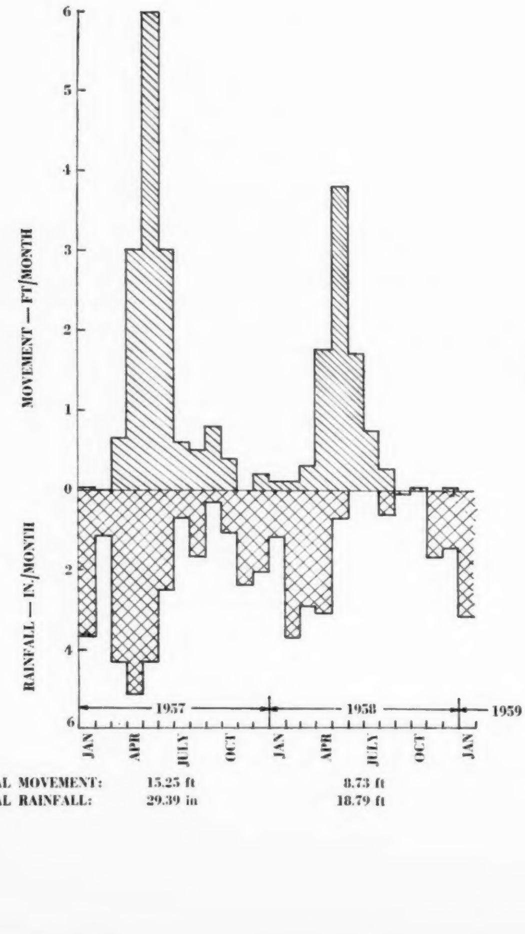
COMPUTED RELATIONSHIP
between K and θ for F.S. = 1

K =	0.4	0.6	0.8	1.00
θ =	28.5°	31.5°	36.5°	45°

COMPUTED RELATIONSHIP
between K and F.S.
for θ = 36.5°

K =	0.8	0.7	0.6	0.5
F.S. =	1.00	1.11	1.21	1.29

Fig. 9. Analysis of slide, Pit A



	1957	1958
TOTAL MOVEMENT:	15.25 ft	8.73 ft
TOTAL RAINFALL:	29.39 in	18.79 ft

Fig. 10. Relationship of rainfall and slide movement, Pit A

movement and the time lag of several months, which suggests that the source of water is not the immediate surface of the slope, but rather some catchment area nearby. Further investigation and the initiation of corrective treatment are now underway. Since even a modest reduction in uplift pressure (see figure 9) would result in substantial increase in factor of safety, the corrective treatment will be directed towards drainage of the fault surfaces.

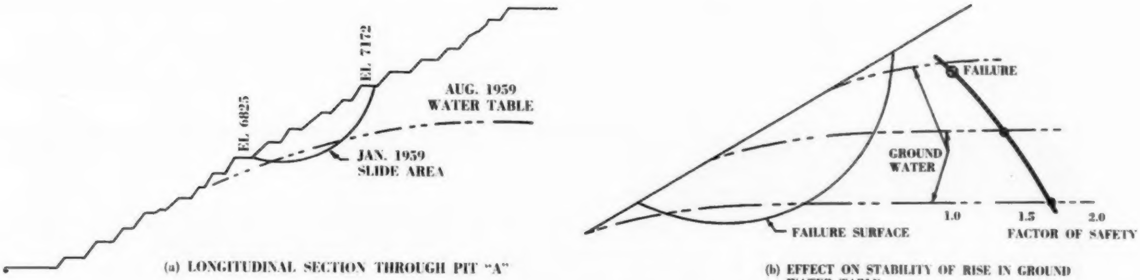
Effect of Ground-Water Level

Along the slope of Pit A just south of the slide shown in figures 2 and 7, a slide zone developed in January 1959. Heavy January rains often occur in this region, and these may develop at a time when the ground surface is still frozen; thus, the normal drainage outlets may be plugged. Figure 11(a) shows a section through this portion of the pit, and the approximate shape of the slide zone. In August 1959, piezometers were installed at various locations along the slope, and the approximate position of the ground-water table as observed in August is superimposed on the section.

Figure 11(b) shows the effect on the stability of the observed slide by a rise in the general ground-water table. Based on reasonable assumptions as to angle of internal friction and cohesion, the present factor of safety of the slide zone would appear to be in excess of 1.50. However, the present spring and summer have been exceptionally dry and it is not unrealistic to assume a ground-water table rise of several hundred feet following periods of intensive rainfall. Such a rise would inevitably be accompanied by a decrease in factor of safety as indicated on the sketch, and at some stage the slope will fail, as it obviously did in January.

Predicting Instability

It is difficult enough to analyze a slope that has failed, to discover why it failed, and to then design corrective treatment. It is much more of a challenge to design slopes of new pits or even the extension of existing pits. The ultimate goal of studies similar to those described in this article is to predict in advance that a particular slope may become unstable, and to then stabilize it *before* a failure develops. Before this can be done, much more needs to be learned about the events which led up to failure of existing slides, and about the exact stress conditions which existed at failure. It is only from such data that



(a) LONGITUDINAL SECTION THROUGH PIT "A"

(b) EFFECT ON STABILITY OF RISE IN GROUND WATER TABLE.

Fig. 11. Influence of ground water on slope stability, Pit A

the in-place shear strength of the soils and rocks which underlie the slopes can be evaluated.

As a further example of the problems encountered in open pit mine stabilization, consider the general view of Pit B, figure 12. In the background is seen the large circular-arc type of slide illustrated in figure 3. To the left of this is a portion that was mined many years ago by block caving methods and consequently is completely broken up. This has proved to be the most stable section of the pit, undoubtedly because of the excellent drainage conditions resulting from the former mining.

In the left background the entire corner has been moving into the pit for years, although without serious consequences. In the immediate right foreground is the flow slide resulting from a high ground-water table above a fault zone.

In the right foreground is the location of a new skipway not yet undertaken when the photograph was taken. Since this slope has proved troublesome in the past, and there are tension cracks above the top of the slope, Slope Indicator observation wells have been installed to give advance warning of impending trouble. That such advance warnings develop have been noted by a number of investigators. Terzaghi[2] has stated that ". . . . if a landslide comes as a surprise to the eyewitnesses, it would be more accurate to say that the observers failed to detect the phenomena which preceded the slide."

Stabilization by Relief of Excess Pore Pressure

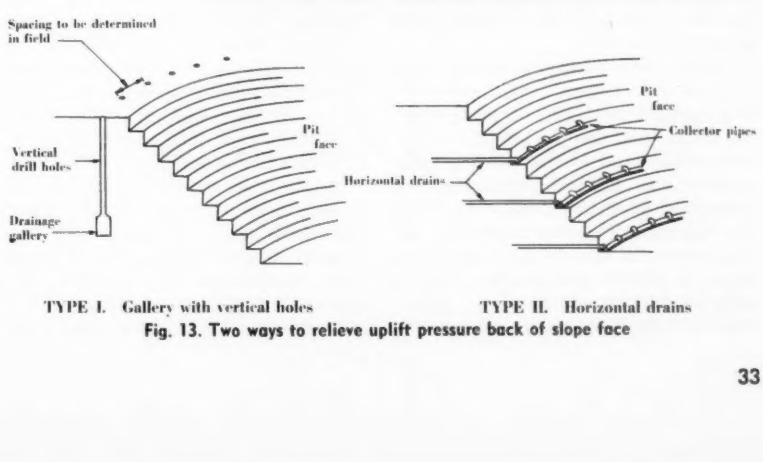
The south pit slope shown on the left of figure 12 is of particular interest. As can be seen, this slope shows surface signs of distress and it is believed that the factor of safety is not greatly in excess of unity. However, the lower portion of this slope consists of copper ore, most of which could be recovered at substantial savings if the inclination of the lower half of the slope could be increased by a mere 5°. This is an example of the challenge that open-pit mines offer to the practical application of the principles of soil mechanics. Yet the enormity of the assignment appalls one who has stood at the brim and looked downward.

Figure 13 illustrates two possible methods of stabilizing deep slopes by relieving the excess pore pressures well back of the pit slope. Obviously, the cost of such stabilization treatment is considerable, and in many instances prohibitive. Before such work is attempted, extensive field observations must be undertaken to assure not only that the proposed method is the most economical, but also that it will work.

REFERENCES

1. Wilson, S. D., "Detection of Landslides," Proceedings, Eleventh Northwest Conference on Road Building, University of Washington, 1958
2. Terzaghi, Karl, "Mechanism of Landslides," Engineering Geology (Berkey) Volume, Geol. Soc. of Amer., November 1958

Fig. 12. General view of Pit B in which varying degrees of stability point up the problems encountered in open pit mine slope stabilization



TYPE I. Gallery with vertical holes

TYPE II. Horizontal drains

Fig. 13. Two ways to relieve uplift pressure back of slope face

WIRE ROPE MAINTENANCE

By A. F. MEGER
Assistant Chief Engineer
Wire Rope Division
John A. Roebling's Sons Corp.

"Loaded" with money saving ideas, here is a distillation of the thoughts and experiences of many persons vitally interested in practical wire rope maintenance

A SUCCESSFUL wire rope program requires careful analysis before plans can be formulated to correct existing problems. A study should be made of rope costs to determine where the major savings can be affected. Here a wire rope company representative can help by surveying the situation, making recommendations to simplify warehouse inventories and providing information on the latest developments in wire rope constructions.

Basic, accurate field reports that require only essential facts and figures, useable for future cost estimates, should be set up. Keeping these reports short and to the point usually means they will be completed and submitted by the field men. As a follow up, management should show the importance of these reports by using them. It should not demand records only to destroy or ignore the information compiled. Also, all persons connected with the program should be informed of its successes and failures. Interest can be kept up by converting dry facts and figures into hours, tons, cubic yards, dollars or any other term that means something to the field men, and then showing them the results.

At least one good man should be educated on the subject of wire rope. In this way he is able to better evaluate the type of rope needed, whether or not the service has been adequate and if this service can be improved. This man can be used as the nucleus for its program, educating and training others through his daily contacts. This work is not to be thought of as a full time job by any means. Generally, a good operating or maintenance man, if given an opportunity, will take deep pride in helping to educate others.

Supply men should be sold on the proper methods of storage, handling and distribution of wire rope. Permanent damage can and does result from mishandling even before the new rope is placed in service. Even though a suitable oil or grease is applied to the finished rope for protection during shipment and storage, it is not tough enough to withstand scraping, rubbing or impact when moving reels in storage. Removal of this lubricant can expose outside wires to corrosive atmospheres, causing premature wire breaks in areas that may never get any severe working action after installation on equipment. Supply men should be cautioned to keep wires lubricated and also to cover or shield wire rope to prevent direct exposure to the elements. A severe spot of corrosion acts similar to a nick or sharp cut, establishing a stress concentration point which will deteriorate rapidly once the wires start flexing over sheaves. Maintenance personnel should be trained in the proper handling and installation procedures, stressing the dangers of mishandling, kinks, heating of the wires by careless handling of a torch, arcing with a stinger, dropping weld spelter on the rope and using the rope as a ground. Rope carbon steel is similar to high grade bearing steel in that temperatures over 400° F start annealing and

What lubrication means. All rope samples and fiber cores are from the same operating rope but the strands showing corrosion have not had the benefit of adequate lubrication. The amount of work done by this corroded section is the same as that done by the worn but lubricated section which at the time of the test, developed 96 percent of catalog strength against 57.5 percent for the unlubricated section. Notice the relative size of the lubricated core as compared with the dry fiber core. As this core diameter is reduced, the wire rope strands are not supported properly, increasing strand contact point pressures and, in severe cases like this, allowing the rope to become unbalanced

dropping the tensile strength of the wires.

This general plan is mentioned to illustrate how easy it is to start a rope program. Getting down to specific cases will further prove the contention that no great amount of money or time need be expended.

Lubrication — A Money Saver and Safety Insurance Policy

Lubrication is one of the best methods of improving rope life. Stop and think about this—wire rope is one of the most versatile, intricate and complex machines in general use today. Hundreds of moving wires are blended to form a flexible load carrying member. Would you operate any other piece of expensive equipment without adequate lubrication? Despite all instructions and warnings, many ropes are installed, used and discarded without application of any additional lubricant, other than the original applied during manufacture. Laboratory tests, practical experience and careful records have proven conclusively that rope life can be extended if proper lubrication practices are observed.

One of the most successful methods incorporates automatic or semi-automatic mist applications of small amounts of a light lubricating oil, just enough to keep the rope damp. Protection against corrosion as well as abrasion is gained. An adequate oil film minimizes internal friction in the rope and at the same time cushions the wear between operating sheaves and the rope itself. Proper lubrication adds a safety bonus, because a light oil usually keeps the rope cleaner, facilitating inspection. A complete description and instructions on how to build and operate a lubrication system for both small or large installations are available from wire rope suppliers.

To emphasize the importance of lubrication, let us take a look at some examples—first, the petroleum industry. Like stripping shovels, drilling rigs are getting larger, going deeper into the earth; consequently, larger and longer ropes are bringing rope costs up. Drillers too are very cost conscious and are starting lubrication programs to reduce wire rope operating expenses. Data will be available from this study in a year or so.

In the case of heavily loaded mine shaft hoists, temperature changes, dirt and moisture problems cause corrosion damage that must be retarded by proper oiling techniques. Service is measured in terms of years, even under these conditions.

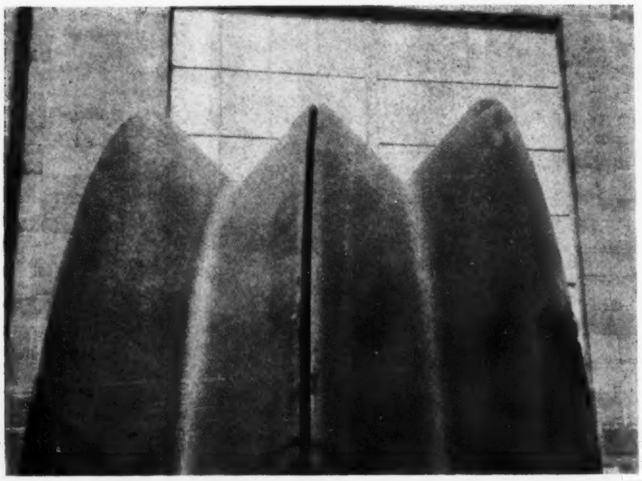
Elevator traction ropes in modern buildings are working under ideal conditions of cleanliness, light loads and frequent inspections, yet all are protected by a film of lubrication. Remove this lubricant and the rope will deteriorate very rapidly. This has been proven many times by tests to determine the importance of proper lubrication.

Lubrication cannot be stressed too strongly as a money saver and an excellent safety insurance policy.

Fit Rope to the Job

In determining the proper type of rope for each particular job, mining companies should take advantage of their rope manufacturer's technical services. Even though wire rope all look very much alike to the layman, there have been changes in wire drawing practices, rope constructions and steel analysis, all resulting in higher ultimate strengths and improved fatigue properties. This should be of interest to everyone responsible for the efficient operation of modern equipment.

The wire rope industry needs the mining industry's help in developing these new products. Most wire for



Groove contour of a set of seven-ft diam alloy steel 90° point sheaves which were removed from a 45-cu yd power shovel after four years' service. Overburden in the pit was composed mainly of extremely abrasive sandstone, yet only moderate wear is visible on the sheaves. Reconditioning costs will amount to a flame hardening treatment of the grooves. Removal of this set was made necessary by a bad bearing and seal; otherwise, many more months of service would have been realized before any reconditioning costs were incurred

Considerable success has been achieved with a movable-wedge type of dead-end fastening on 65-yd power shovels. Excellent gripping efficiency, low maintenance, plus ease of rope removal and installation make this a worthwhile contribution to the problem of dead-ending larger ropes. No special end preparation of the rope is necessary. Should any unbalance occur in a rope, it will generally concentrate directly under the grip and moving a ten-ft section through the jaws bypasses this problem, permitting continued operation with the same ropes

wire rope is made from Improved Plow Steel today. This steel was developed by the rope industry prior to 1920, but not until after 1935 did consumers accept it as the standard quality rope. Today most rope manufacturers have moved up another step to an Extra Improved Plow Steel. Must everyone wait another 10 to 15 years before this 15 percent stronger steel is accepted? At the rate faster and larger machines are being designed and built, these higher strength products are needed right now! The wire rope industry would appreciate coal's cooperation in using these Extra Improved Plow Steel ropes so that field experience will furnish the data necessary to further improve their fatigue qualities and strengths. Laboratory work is necessary but field experience is the final judge. The wire rope industry's ability to continually improve rope depends a great deal on consumer's willingness to use new developments as they are introduced.

Equipment design changes keep pushing loads and speeds ever higher. This is as it should be. Examples of this trend are the 65 and 70 cu yd machines now in use and a 115 cu yd machine already on order. The wire rope industry has been confronted with the challenge of making 2½ to 3-in. diam ropes that will operate at extremely high speeds and loads. The challenge has been met but engineering work continues, trying to keep ahead of further machine improvements.

Equipment Design—Improved Sheaves, Drum Lagging

One phase of rope maintenance that should be of particular interest are the advances made in design and construction of sheaves and drum lagging. Practical field experience has proven the value of the 90° throat angle on fixed point sheaves for shovels that dig with extreme fleet angles. New casting and fabrication techniques developed recently have provided better deflection and padlock assemblies of alloy steels, using standard throat angles and the latest recommended groove diameters to give needed support to the rope under severe loads. These sheaves, machined, polished to minimize wire abrasion, then heat treated to 40–45 Rockwell C for good wearing characteristics, should produce the ultimate in rope life at these points. The bonus does not stop here, for whenever maximum wear does occur, automatic welding techniques are used to rebuild both groove and throat. After machining, grinding and heat treating, the user again has a new unit at a considerable saving. Remember, smooth, hardened, surfaces are extremely important. Tool marks, cracks or pit marks can cut steel off rope wires just like a coarse file. Drum lagging is also best when made of tough alloy materials. This too should be properly machined, polished to size and spaced or pitched to give adequate clearance between wraps to avoid side scrubbing and consequent wire damage.

End Fitting Subject to Wear

End fittings are neglected many times because they are considered nonwearing items, yet this is entirely wrong. All fittings are subject to wear as the rope pulls into final position. Reuse, without inspection, creates a condition that can easily lead to rope failure.

The machined wedge and socket assembly, commonly used on hoist or counter-weight ropes, is an excellent example. Machined to specific tolerances, this fitting will produce a 90 percent efficiency against 75 percent for a rough casting. However, if too many cycles are permitted without replacement or repair, the rope will not be clamped properly on the live side, allowing a transfer of load to the back of the wedge, unbalancing the rope and causing broken strands to appear in or just ahead of the socket. The use of inexpensive go and no-go gages will warn the field crew when

to replace or route the wedge and socket assembly to the shop for rebuilding and machining to original specifications.

Rock Damage Greatest Cause of Short Rope Life

In the writer's experience with both live and dead ropes on buckets, rock damage is by far the greatest cause of short rope life, if the operator grows the least bit careless. When the highwall is permitted to overhang or is not cleaned properly of loose material, falling rocks can hit the leading side hard enough to distort or rip wires out of position. Even small hard pebbles, if dropped between the sheave of either an operating or live rope, or an equalized or dead rope, can severely damage one or two strands and eventually cause removal. This damage may not be noticed immediately, and when the rope fails prematurely, complaints of sudden failure are heard.

Whenever practicable, broken wires should be clipped as they appear or they in turn damage others in rapid succession. Damaged wires clipped immediately will seldom offer any trouble, nor do a few mean any appreciable loss in strength—but leave them on and you lose a rope.

Many times there is evidence of damage cause that can be found under a microscope. Very rarely does a rope fail all in one spot without some definite outside assistance in the form of an overload, a severe bend, rock damage, scrubbing on the highwall, jumping a sheave, rubbing or peening on the boom and sheaves or mishandling, as listed previously.

The necessity of a break-in period should be recognized for all ropes and strands. A few minutes spent operating the new assemblies at very light loadings will pay off in rope life. All wires must gradually adjust to accept their share of the load. If full loads are imposed on new assemblies, premature wire breaks can be expected.

Experimental Work on Equalizer Sheave Problem at Ken Mine

Dead or equalizer sheaves are another source of difficulty under certain conditions. Wires tend to fatigue at the points of tangency where sheave and rope part. Shifting of the rope, once a permanent set has taken place, will only tend to break wires at a faster rate. Careful inspection of equalizer sheave rope tangency areas should be stressed because of the tendency to overlook parts that do not move as normal rope sections do. Lubrication is very important at these points, to minimize friction and nicking.

Ralph Bailey, superintendent of Peabody Coal Company's Ken mine, and Floyd Spriggs, master mechanic, have experimented with the equalizer sheave problem on their 1050-B. In an effort to more efficiently equalize loads on the boom, Spriggs decided to cross-reeve his hoist lines so that each line started at one drum, led to a point sheave, down to a bucket sheave, across to the other bucket sheave, up to the opposite point sheave and back to the other drum. This gave a free-floating or rocking action to the bucket, which in the opinion of the operators, provided better digging characteristics, and from repair records, definitely minimized boom twisting. They do not have enough experience at this time to say whether or not the new setup will replace the old, but Ken Coal is certainly to be congratulated for their experimental work to-date.

Rope Changing Efficiency

Have you ever considered a careful study of rope changing time on larger machines? A 5561—45 cu yd Marion (2⅜-in. diam rope) should require about 40 to 60 minutes. It has been the writer's experience to watch the total 5760 double-hoist rope change time drop from eight hours to an average of four, with some claims of 2½ hours, showing what can be done by planning. The point is this—if these large units can be changed so rapidly, why can't smaller units be even more efficient. Possibly a few pieces of special equipment will give the added speed and safety needed. Sturdy reel cradles or skids, with adequate reel brakes, are important. Fast winches, with control buttons properly located, and use of a power megaphone will help coordinate the crew's actions. Inspect catwalks and handrails to provide safe, sure footing for the men. Using ⅝ or ¾-in. wire rope for flexible hand rails will eliminate breaks in these rails due to shovel vibration.

Smaller Equipment

Shovels seem to dominate any discussion of wire rope used in the stripping fields, but this should not be so. Dozers, scrapers, carryalls, conveyors and car retarders all use appreciable amounts of rope. Again, design changes have resulted in heavier, more efficient units. Careful inspection of brakes, friction clutches, groove sizes and the use of standard mounted reels will all contribute to lowered costs. If a dozer blade size has been increased, the operator should consider the 15 percent higher strength Extra Improved Plow Steels and new construction ropes. In this way he may not have to increase the rope and sheave grooves. Sheave bearings and groove sizes of all smaller equipment should be inspected, for here too can be found dollar savings in rope life.

Boom Supports and Slings

In regard to the latest improvements in boom support assemblies, swaged fittings are highly efficient and reports of longer life are very encouraging. Boom strand constructions have one outstanding safety feature, they seem to start breaking wires on the outside, where visual inspection can detect them. Prestressing above working loads has improved strand life. Length tolerances are smaller, allowing removal of mechanical equalizing assemblies in some instances.

Remember, too, in maintenance work, slings with mechanical splices (pressed tapered sleeves) are safe and sure, developing full catalog rope strength, not just the 80 percent developed by clips. The high cost of labor plus clips and rope make this phase of a company's program a likely place to save dollars. Making your own slings is not always as inexpensive as it seems to be before careful inspection of costs.

To touch briefly on the subject of engineering assistance, all wire rope manufacturers are extremely interested in working with customers to solve particular problems. Engineers are available to investigate, recommend and work with coal men, combining field experience with design work to constantly improve wire rope for them. Companies should take advantage of this service for any particularly difficult problems.

Many progressive companies throughout the country have instituted training programs to which manufacturers are invited to act as instructors. They welcome the opportunity to participate in constructive programs such as these and can offer practical information on rope manufacture, maintenance and application.

In conclusion, a wire rope program is basically good maintenance procedures plus a generous application of common sense. The dollars saved in rope costs, machine down-time and general safety around a mine will make management ask, "Why haven't we done this before?"

Use of Yieldable Steel-Ring Sets at Silver Mountain

It was impossible to maintain openings in the Deadman shear zone with rigid supports. This ground, in effect, was a plastic mass under great pressure, which would actually flow into all open voids

By

WALLACE E. CRANDALL

Chief Engineer

Hecla Mining Co.

THE Silver Mountain Exploration Project, operated by Hecla Mining Co., is a joint venture of the Bunker Hill Co., Hecla, and Silver Mountain Lead-Mines, Inc., with Defense Minerals Exploration Administration participation. The Silver Mountain property is located in the Hunter Mining District, two miles east of Mullan, Idaho.

The project was planned to explore two main East-West structures—the Paymaster fault zone, some 1000 ft north of the shaft site; and the Snowstorm area beneath the old Snowstorm mine, some 7000 ft north of the shaft site. Work began in February 1956. A 2000 ft, three-compartment shaft was sunk, the northerly crosscut to the Paymaster was driven and 3000 ft of lateral work done along the Paymaster fault. To date, a total of 9622 ft of crosscutting and drifting and 12,400 ft of diamond drilling have been completed with the last stage of diamond drilling now in progress.

Heavy Ground in Deadman Shear Zone

In order to crosscut to a location where the Snowstorm area could be diamond drilled, it was known that the Deadman shear zone would have to be crossed. At a point some 3350 ft northeasterly from the shaft, the ground became increasingly sheared and heavy, requiring both rock bolting and timber sets on five foot centers.

Up to this time, rock bolts had been used very successfully to hold several badly sheared and broken sections of Wallace and St. Regis formation. The bolts pinned the ground together even though the entire wall, rock bolts and all, would squeeze in. In several instances after the cross-section of the crosscut became too small, the bolts were found to still be well anchored and the ground was trimmed back, the bolts cut off, re-threaded in place, and re-tightened. The anchorage of these bolts was improved somewhat by the ground squeezing the hole shut around the bolt.

After timbering and bolting some 65 ft of the Deadman shear zone, the sets began breaking in one to two weeks and repair became a full time job. Excessive heaving of the track also occurred at the face, and it became apparent that this ground could not be held by this method. At this time a diamond drill hole was drilled ahead of the face, perpendicular to the shear zone, to determine the extent of the heavy ground remaining. It was found to be some 350 ft wide. After the gouge in the drill hole became wet, the drill rods could not be held in the hole, and when they were pulled the last time, the fault gouge followed the rods out and was extruded from the collar of the hole.

Previous experience had shown that, up to a point, the ground could be rock-bolted and timbered and then relieved by repair or retimbering. Framed 12 by 12 in. timbering with a sill piece under the track was considered, but the idea was discarded because of the large excavation necessary and the fact that its strength would still not be sufficient. Reduc-

In several instances before going to yieldable steel sets, after the cross-cut had squeezed in, rock bolts and all, the bolts were found to still be well anchored. The ground was trimmed back, the bolts were cut off, rethreaded in place and retightened

ing the set interval would have given more strength but a costly repair problem would still have existed.

Rock-Bolts Held Ground Better Than Timber

The best solution appeared to lie in a ground support method which would allow yielding, eventually transferring the load from the support back to the ground itself in a pressure arch or ring around the crosscut. It had been noted that rock-bolted sections in heavy ground had a "yielding effect," which allowed the ground, even though unconsolidated, to be held together as a unit by the bolts. This gave the cross-section of the opening greater strength and made it possible to hold the ground more successfully with bolts than with timber. Eventually, the inward motion of the periphery of the cross-cut would cease even though the crosscut decreased considerably in area.

This transfer of the load from the supporting member back to the ground in an arch or ring about the opening is the theory behind the yieldable steel ring or arch. As the support yields, the weight of the ground is transferred from the support back to the ground so that the natural arch of the ground will then carry the major share of the load. A rigid support cannot uniformly distribute these pressures back to the ground and under excessive pressure will ultimately fail.

The forerunner of the present yieldable steel arch or ring was the yielding steel prop used in longwall mining. This prop permitted slight yielding under excessive loads and controlled roof subsidence while mining progressed. At the present time Hecla uses the German made Becorit steel prop at the Radon mine in Moab, Utah, in conjunction with a longwall system of mining (Ed. Note: See *Mining Congress Journal*, August 1958, p. 34).

The decision was then made to use eight ft diam., 15 lb per ft, Bethlehem yieldable steel ring sets on 4½ ft centers, and the first sets were installed in March 1958. This particular ring was used because it was available without delaying the operation. The 4½ ft spacing was selected at the time because lacing material was available in ten ft lengths, and it was desired to lap the joints six in. rather than butt them. This was because the width of the ring is only five in. and enough longitudinal motion might have occurred to allow the lagging to slip off the ring if butt-joints were used.

Spiling Provided Temporary Support During Advances

The ring set consists of four equal U-shaped quadrants, which nest together at the joints and are clamped at each joint by two heavy U-bolt clamps forming a yielding friction joint. The rings are rolled from high-tensile strength, medium carbon steel in the 95,000 to 105,000 psi range. Normally 180 to 200 ft-lb of torque are applied on the U-bolts to give the correct friction for yielding. However, because of uneven pressure causing deformation of the sets, a torque of 150 ft-lb was used on these sets so that they would yield rather than deform.

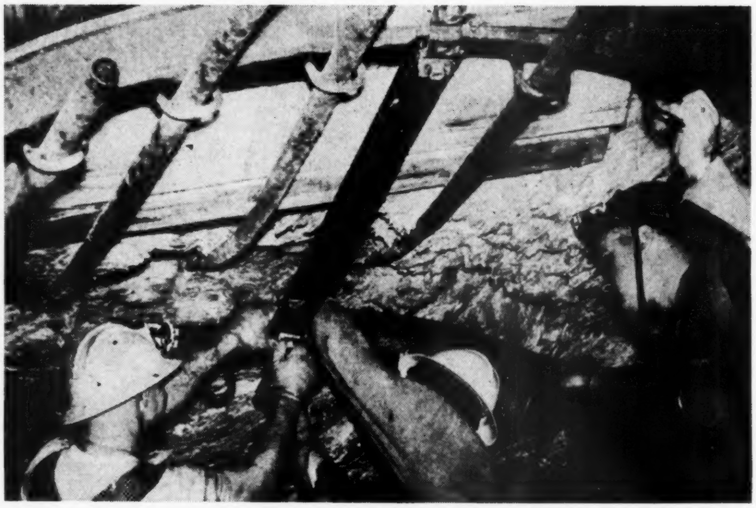
The rings were installed as the face advanced. To supply temporary support while a ring was being installed, the face was spiled ahead of the round to be blasted by drilling four or five, 9-ft holes in the face at the back with a 2½ in. bit. U-shaped loops of ½ in. rod were tack welded to the underside of the upper quadrant of the last ring. Used 1¼ in. standard pipe was then driven into the holes with the drifter on the jumbo. A 5-ft round was then blasted, breaking to the spiling, which supported the back while the ring set and lacing were installed. This spiling proved very satisfactory and was removed after the set was installed. An eight in. diam standard pipe drainline was installed outside the rings for a water ditch. An

When deformed sets were removed for repair, it was found that the lacing had been compressed like barrel staves and had to be blasted out. Ground, which previously ran like loose gravel, was compacted until it had to be picked out

indication of the tremendous forces brought to bear was shown when this drain line was later found to be crushed flat.

The round was mucked out with a mucking machine to track level. Below the track, about two cars were mucked by hand to make room for the ring and lacing. This material was used for backfill about two-thirds of the way up the side of the set. The remainder of the space was tightly bulkheaded with split cedar lacing to give as even a pressure as possible all the way around the ring. This was important as an aid to quick formation of the pressure arch. The lacing was 4 in. by 10 in. by 5 ft fir, lapped six in. at the joints, and placed tightly together with no spaces.

A total of 102 sets were placed in this manner. The sets were kept as close to the face as possible and overbreak was held to a minimum. A record of the movement of the first 52 sets was kept, and it was found that the greatest movement occurred during the first week after installation. The movement then slowed down but would continue for six weeks or more before stabilizing.



To provide temporary support while a ring was being installed, the face was spiled ahead of a five-ft round to be blasted by driving 1¼-in. pipe into four or five, 2½-in. by 9-ft holes that had been drilled at the back. When the round was blasted, it broke to the spiling

Diagonal Pressures Deformed Steel Rings

The shear zone in general became heavier as drifting proceeded from hanging to footwall. In the footwall half of the zone, the fracturing of the sheared rock turned so as to nearly parallel the crosscut in strike. This caused a diagonal pressure, perpendicular to the shear planes, to bear on the sets resulting in unequal yielding of the quadrants. The rings yielded to an oval with the axis at about 45° to the horizontal. This interfered with proper yielding and produced deformation which caused some of the rings to fail.

Repair became necessary some time after passing through this area since the men could no longer get the equipment through. These deformed sets were removed and straightened in the company's shops using an air hammer and male and female dies made from the rings themselves. The straightening was done cold when possible or with heating to temperatures no higher than 1000° F to preserve the temper in the steel. Straightening of these rings was quite successful and only three quadrants out of 25 rings were broken.

Diagonal pressure on the rings interfered with proper yielding and produced deformation which caused some sets to fail

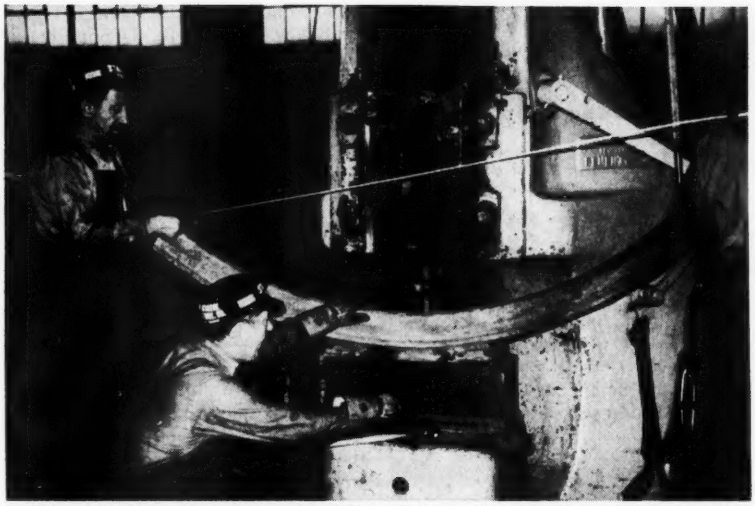
When the deformed sets were removed for repair, it was found that the lacing had been compressed like barrel staves and had to be blasted out. The ground, which previously would run like loose gravel, was now compacted till it had to be picked out. The finely crushed talcy material had been driven tightly into every void.

Since it was evident from the breaking of lacing and deformation of the sets that set spacing was too great in the heaviest area, the repaired sets were doubled up to two ft three in. centers. The same five-ft lacing was used, with shims to make it bear on the intermediate ring. Of the original total of 102 sets installed, 40 were removed and replaced. Fourteen of these replaced sets were doubled up to two ft three in. centers for a total of 47 sets replaced. These doubled up sets held the ground with no further trouble and without deformation.

For the 453 ft of advance and repair the direct labor cost was \$38.59 per ft, material, \$45.58 per ft, for a total of \$84.17 per ft.

Experience Points the Way to Improvements

The experience gained in the use of steel ring sets indicates that several changes would be of benefit. Because of the minimum opening that can be passed through with present equipment, the rings can only yield or deform about 18 in. before there is insufficient room and the set must be replaced. Therefore, the original sets should have been of a larger diameter, say nine or ten ft. Also, the set



Deformed sets were removed and straightened in the shop using an air hammer and male and female dies made from one of the rings

spacing should have been somewhat closer to start with—approximately three ft. Then the 15-lb ring would have been strong enough to prevent deformation and allow sufficient yielding to transfer the weight back to the ground and still end up with sufficient room for equipment to pass. This would have prevented the need for repair, which sometimes resulted in the loss of the arch in the ground and started the ground movement all over again.

To prevent too sharp a contact angle of the lagging with the ring, which would cause a lateral pressure on the rings, full five ft lagging was used on the sets placed on two ft three in. centers. If the sets had been placed on three ft centers, probably a six ft six in. lagging should be used with shims to bear on the intermediate. Four in. thick lagging was sufficient for thickness. Even though there was considerable breakage, no set failed because of the lagging giving way.

The loops welded to the rings to act as spiling supports left weld beads after the loops were knocked off. These welds sometimes interfered with yielding of the nested quadrants. In the future, a loop which simply hooks over the ring will be used.

Considerable U-bolt breakage was experienced because the portion of the U-bolt against the lagging dragged in the wood during yielding. This would not allow the U-bolt to stay perpendicular to the ring and caused wide fluctuation in bolt tension with considerable interference to yielding. This situation was much improved by welding two straps (½ by 3 by 10 in.) between the two U-bolts to make them act as a unit and remain perpendicular to the ring. When the U-bolts hung up in the wood, they did not follow the ends of the quadrants as they yielded. This allowed the outer quadrant to straighten out and drive itself into the lacing, which stopped the yielding and caused deformation. Bethlehem now has a clamp device on the market which causes the U-bolt next to the end of the outer quadrant to follow it, preventing this effect.

Pack All Voids Tightly

In addition to the above changes it is important to disturb no more of the ground than is necessary, keeping the ground opening as near in size to the rings as possible. All voids must be packed or filled tightly to assist in even pressure distribution and transfer of the load back to the ground. Also, in this type of sericitic, talcy ground, holding the quantity of water used to a minimum is important as the lubricating effect causes appreciable bottom heaving.

Although installation and repair costs were quite high, it is felt that it would have been impossible to hold this ground with a rigid type of support. It was, in effect, a plastic mass under great pressure, which would actually flow into all open voids, and we are fully satisfied that the yieldable ring is a very satisfactory support in this type of ground.

Fine Coal Cleaning with the Feldspar Jig

A feldspar jig has proven to be the answer to a small coal producer's problem of washing coal containing 18 to 26 percent reject and 20 percent near gravity material

**By R. K. BOGERT, JR., President
Badger Coal Co., Inc.**

BADGER Coal Co., Inc. commenced coal cleaning operations during April 1957 in a new washing plant designed and built by McNally Pittsburg Manufacturing Corp. The plant is located near Philippi, W. Va.; the coal mined is the Kittanning seam.

Due to washability characteristics, which showed a high percentage of accumulation near the desired separating gravity, a dense media Tromp bath washing system was installed to clean plus ¼-in. coal. Another factor influencing this decision was the future possibility of a necessity to clean at even lower gravities in order to satisfy market demands.

It was also decided, after examining the preliminary washability data, that the ¼-in. by 0 coal could be loaded raw if it were not contaminated too much by handling from the mine to loading points. At least it was a calculated risk worth taking because initial capital investment for a completely new installation was of prime importance.

When cleaning operations commenced it was learned that the quality of raw ¼-in. by 0 coal as loaded was much lower than hoped for. Ash was approximately 20 percent, which was double the amount that could be tolerated to obtain the desired Btu content. This condition was caused by degradation and freeing of high ash banded material resulting from mining operations and transfer from the portal through a large raw coal storage bin, crusher, and raw coal vibrating screens.

Immediate steps were taken to obtain information necessary for corrective measures by retaining Commercial Testing & Engineering Co. to make a complete analysis of the ¼-in. by 0 through product from the raw coal screens. Pertinent results of these tests are shown in tables I, II, and III.

This analysis, coupled with negative results from a dry cleaning test, space limitations and again the necessity to keep capital investment to a minimum, prompted the selection of a McNally feldspar jig as the cleaning unit. It was further decided to install centrifugal drying only instead of complete thermal drying. The equipment selection has proven to be very satisfactory. The washer is delivering an acceptable product and moisture is reduced by the centrifuge to as low as 3.5 percent surface; the latter is due to a very fortuitous circumstance in that the coal proved to be extremely water repellent.

Alterations Necessary to Obtain Satisfactory Results

This was the second installation of a feldspar jig in the United States, and understandably, mechanical operating difficulties were encountered at the outset. Reject percentages at first varied from approximately 20 percent to nearly 40 percent. Mining conditions have since reduced rejects to below 20 percent. Originally air lifts were used to handle the refuse and they were not capable of coping with the sudden and extremely high solids percentages encountered. The air lifts were then replaced by pumps since this was the simplest and quickest solution.

Again, plugging occurred at frequent intervals due to the same conditions as previously stated plus the fact that sufficient excess pumping water was not available. Eventually it proved necessary to move a refuse screen from its location over the refuse bin to a point immediately below the washer. This provided free flow from the bottom hutch valves to the screen. The over-product refuse was then conveyed by scraper to the refuse bin and 48-mesh by 0 only pumped to a disc filter.

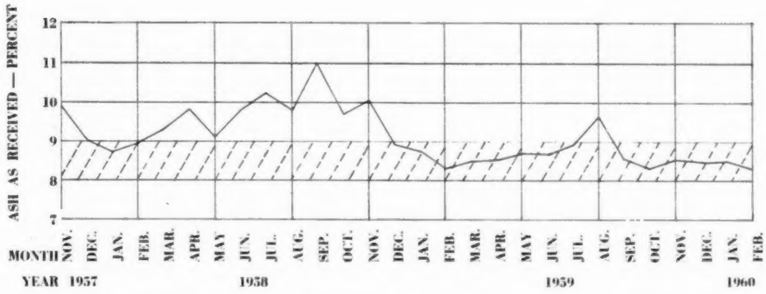
After making these mechanical alterations and training the operating personnel, satisfactory results were obtained consistently. Graphs I and II show the deviation in ash content due to the difficulties encountered and final solutions used.

Another overriding factor that should be mentioned which caused higher ash reports during July and August, 1959, was the loading of a considerable amount of augered and some substandard coal for lake shipment.

Dense Media System Used to Clean Plus ¼ In.

Although this article is primarily presented as a description of the fine coal cleaning section of the Badger plant, that section is still an integral part of the complete operation and cannot be described properly without at least generally discussing the entire flow sheet. Figure 1 illustrates the complete plant flow.

The plant is rated at 250 tph input raw coal from a mechanized belt mine with the top size of coal being approximately 14 in. The raw coal is transported by belt from the mine portal to a 500-ton storage bin. It is then crushed to 6 in. by 0 and elevated to the top of the cleaning plant where a ¼-in. separation is effected on two tandem vibrating screens. Some fresh water, together with recycled clarified water, is used to make an effective wet screening separation on these vibrating screens. Over product, or the 6 by ¼-in. fraction, is delivered to a McNally Tromp dense media washing vessel. Clean coal from the bath is rinsed and dewatered, then delivered to a double roll crusher for reduction to the desired



Graphs I and II. Deviation in ash content of jig feed. Graph I (top) shows the ash analyses by months from the time of initial installation of the jig in November 1957 through February 1960. Graph II (bottom) shows ash analyses for each day's operation during the month of January 1960. Cross hatched portion indicates target ash zone.

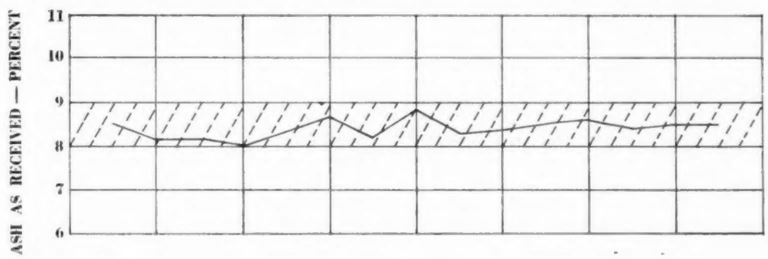


Table I. Proximate analysis of the ¼-in. by 0 raw coal feed at Badger

	As received	Dry basis
% Moisture	1.84	....
% Ash	19.93	20.30
% Volatile	28.52	29.05
% Fixed Carbon	49.71	50.65
	100.00	100.00
Btu	11,880	12,103
% Sulphur	2.44	2.49

top size the company's market requires. Refuse flows from the bath to a dewatering and rinsing screen and then continues by gravity to a bin for disposal by truck.

To recover magnetite a dilute-medium sump is incorporated to collect the underflow from both rinsing sections of the floats and sinks screens; a medium storage recirculating sump receives the underflow from the drainage sections of these screens. The dilute medium is pumped back up to the magnetic separator to recover the magnetite which is returned to the medium storage sump. A portion of the dilute medium is diverted for rinsing on the floats and sinks screens. Tailings from the separator are purged from the circuit by being directed to the rinsing section of the raw coal vibrating screen. This is done for two reasons: there is some degradation and some inefficiency in screening; thereby, recoverable coal is present in these tailings and in this fashion it joins with the ¼-in. by 0 for washing in the fine coal section of the plant. An automatic density regulator continually samples the medium which is being returned to the bath and in turn automatically controls gravity.

The through product from the raw coal vibrating screen, consisting of ¼-in. by 0 raw coal plus water, is received in a drag type recovery feed tank from which it is delivered to the feldspar jig at approximately 40 percent solids. Clean coal from the jig is dewatered over a vibrating screen surfaced with 48-mesh equivalent screen cloth. The dewatered coal is dried centrifugally and may then be loaded as a separate product or delivered to the coarse coal loading point and mixed with the product from the dense media section. Overflow from the clean coal dewatering screen, together with effluent from the centrifugal drier and overflow from the drag feed tank, is received in a sump and pumped to a bank of three 14-in. cyclones; thickened underflow from the cyclones joins the product from the feed tank for return to the jig feed. Clarified overflow from the

Table II. Screen analysis of the 3/16-in. by 0 raw coal made in 1957

Size			Dry Basis	Cumulative Results: Retained on screen in column 2		Cumulative Results: Passing screen in column 1	
Passing	Retained on	% Wt.	% Ash	% Wt.	% Ash	% Wt.	% Ash
	3/16" rd.	3.6	21.88	3.6	21.88	100.0	20.02
3/16" rd.	8 mesh	24.8	17.84	28.4	18.35	96.4	19.95
8 mesh	10 mesh	16.5	19.89	44.9	18.92	71.6	20.68
10 mesh	14 mesh	12.4	19.77	57.3	19.10	55.1	20.91
14 mesh	28 mesh	17.3	19.51	74.6	19.20	42.7	21.24
28 mesh	48 mesh	10.5	20.73	85.1	19.39	25.4	22.42
48 mesh	100 mesh	6.2	23.76	91.3	19.68	14.9	23.62
100 mesh	200 mesh	3.0	25.72	94.3	19.87	8.7	23.51
200 mesh	0	5.7	22.35	100.0	20.02	5.7	22.35

Dry Basis	% Ash	Btu
3/16" rd. × 48 mesh	19.40	12,274
48 × 100 mesh	23.76	11,539
100 × 200 mesh	25.72	11,305

Table III. Float and sink analysis of the 3/16-in. by 0 raw coal made in 1957

Specific Gravity			Dry Basis	Cumulative Recovery (Float)		Cumulative Reject (Sink)	
Sink	Float	% Wt.	% Ash	% Wt.	% Ash	% Wt.	% Ash
+ 3/16" Rd. × 48 Mesh = 85.1 of 3/16" × 0 Raw Coal							
	1.35	58.9	5.76	58.9	5.76	100.0	19.83
1.35	1.40	9.9	13.28	68.8	6.84	41.1	39.98
1.40	1.45	4.5	18.13	73.3	7.54	31.2	48.46
1.45	1.50	2.7	22.11	76.0	8.05	26.7	53.58
1.50	1.55	1.8	26.14	77.8	8.47	24.0	57.12
1.55	1.60	1.3	29.95	79.1	8.82	22.2	59.63
1.60	1.70	2.2	35.34	81.3	9.54	20.9	61.47
1.70	1.80	1.3	42.44	82.6	10.06	18.7	64.55
1.80		17.4	66.20	100.0	19.83	17.4	66.20

Dry Basis	% Ash	Btu
Composite 1.50 Float Coal	8.05	14,165
Composite 1.60 Float Coal	8.82	13,889

cyclones is delivered to the recirculating sump and then pumped to the washer at points below the screen plates in each cell. This clarification is necessary to prevent contamination of the make-up water and loss of extreme fines to refuse. A number of by-pass alternates are provided in this recycling circuit to prevent a build-up of fines if it should occur. However, normally these by-passes are not necessary and the fines build up only to a point that is not objectionable and eventually leave the circuit with the clean coal.

Refuse is withdrawn from the first two cells of the jig directly to a vibrating dewatering screen equipped with ½-millimeter cloth. Over product from the screen is conveyed to the coarse coal refuse bin. Under product from this refuse screen is pumped to cyclone thickeners; underflow from the thickeners is dewatered in disc type filters. The filter cake is then conveyed to the refuse bin, the filtrate is returned to the fine coal circuit as make-up water, and the overflow from the cyclone thickeners, consisting of the plant bleed, is pumped to ponds to purge the system of extreme fines and clays. A detailed description of the vacuum filter system is not necessary because it consists of the standard accepted method and can be followed through on the accompanying flow sheet.

Table IV. Distribution of clean coal and refuse at various specific gravities

		Sp. Gr. Analysis In % of Products		Sp. Gr. Analysis In % of Feed		Distribution % of Fraction Reporting To:	
Fraction Sink Float	Feed	Washed coal	Refuse	Washed coal	Refuse	Washed coal	Refuse
1.30	26.8	32.50	0.28	26.75	0.05	99.8	0.2
1.30 × 1.40	46.5	55.74	3.56	45.87	0.63	98.6	1.4
1.40 × 1.45	6.1	6.98	1.98	5.75	0.35	94.3	5.7
1.45 × 1.50	2.9	2.76	3.50	2.28	0.62	78.6	21.4
1.50 × 1.55	1.8	0.90	6.04	0.73	1.07	40.6	59.4
1.55 × 1.60	1.4	0.48	5.71	0.39	1.01	27.9	72.1
1.60 × 1.80	3.6	0.52	17.91	0.43	3.17	11.9	88.1
1.80 × 2.00	2.3	0.12	12.43	0.10	2.20	4.3	95.7
2.00	8.6	0.00	48.59	0.00	8.60	0.0	100.0
TOTAL	100.0	100.00	100.00	82.30	17.70		

Washed coal	% Wt.	Refuse	% Wt.
1.50 Float	97.98	1.50 Float	9.32
1.50 Sink	2.02	1.50 Sink	90.68
	100.00		100.00

	% Wt.	
Washed coal	82.30 × 2.02 % Sink = 1.662	
	17.70 × 9.32 % Float = 1.649	
	100.00	3.311 Total misplaced material

Each Piece Of Feldspar Acts As A Valve

The so-called feldspar jig is not a recent development. It has been used extensively in Europe for several years and is now being installed in a majority of mines through many foreign countries. Some typical large foreign manufacturers are Preparation Industrielle des Combustibles (P.I.C.) of France, Schutermann & Kremer-Baum (SKB) of Germany,

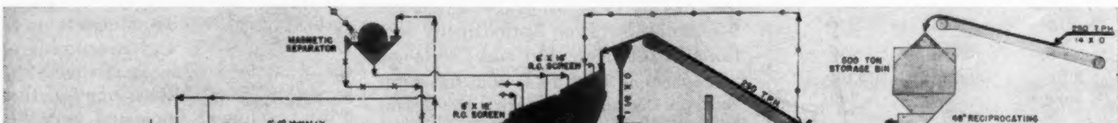


Fig. 1. Flowsheet of Badger plant, which is rated at 250 tph raw coal input from a mechanized belt mine

and Coppee of Belgium. Most installations are for coal no larger than 3/8-in. or 1/4-in. by 0 with tonnages ranging from 15 to 150 tph in a single unit.

The jig installed at Badger, manufactured by McNally Pittsburg, has three washing cells in line, each three ft long by six ft wide. Approximately two ft below the water level a flat screen with 5/8-in. round perforations supports a feldspar bed; thickness of this permanent bed is approximately six in. and consists of pieces three-in. top size and 3/4-in. bottom size. Each of the cells is independently sealed below the screen plate level with separate withdrawal valves to remove refuse from the first two cells and middlings from the third cell which is recycled to the feed.

As coal progresses through the washing compartment, it is stratified gravimetrically by a successive series of jigging impulses. Air intermittently forces water up through the screen plate, opening up the feldspar bed and lifting the coal and water in the washing compartment; then, as the air pressure is released, stratified refuse at the bottom is hutched through the bed until it settles into a locking position. Intensity of the impulse and consequently the amount of hutching accomplished is automatically controlled in each cell by a device that senses the concentration of heavy material at the bottom of the bed. This adaptation of the Baum washing principle will be described in more detail later in this article.

Clean coal overflows a weir at the end of the last cell with water. Obviously the stratification of fine coal must be accomplished under closely controlled conditions that will prevent eddies, violent impulses, and undue disturbance of any kind. This is the reason for the application of special design features not found on the conventional Baum jig. Feldspar is used as the permanent bed since it has been found to have the particular characteristics best suited for this application. The fracture is such that it provides the proper valve closing action. The specific gravity is enough higher than the refuse that it does not tend to migrate upward in the bed and it is not so high that it cannot be lifted without imposing violent impulses. Also, its hardness prevents wear. As an example the original charge of feldspar is still in use at the Badger plant which was first started in November 1957.

Refuse Sinks Through The Bed

The method of cleaning with the feldspar jig is an adaptation of the well known "Baum" principle whereby the coal is subjected to a series of jigging actions, while submerged in water, to accomplish stratification vertically according to particle specific gravity. In the conventional Baum jig for coarser coal the entire bed moves horizontally over a perforated plate to the end of the washing compartment. At this point stratification has been accomplished and a separation is made by cutting the bed at the proper level to obtain the desired clean coal product at the top and refuse at the bottom.

The fine coal jig described here removes refuse in a different manner, that is, by hutching downward through the screen plate upon which a permanent bed of feldspar is re-

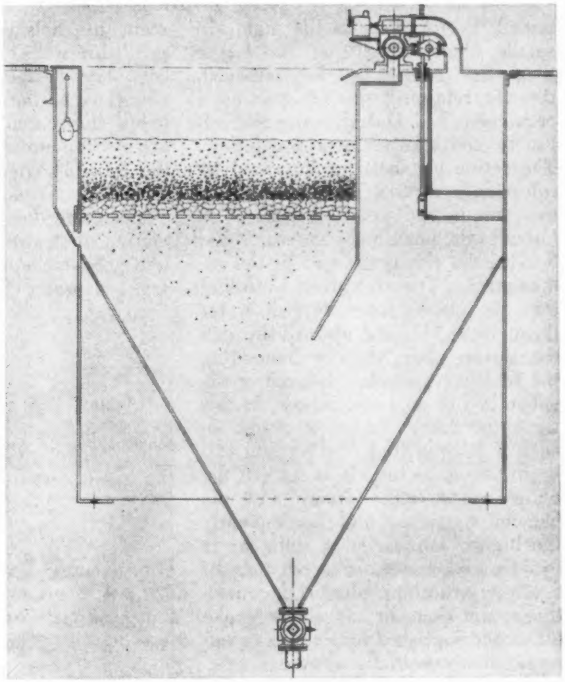
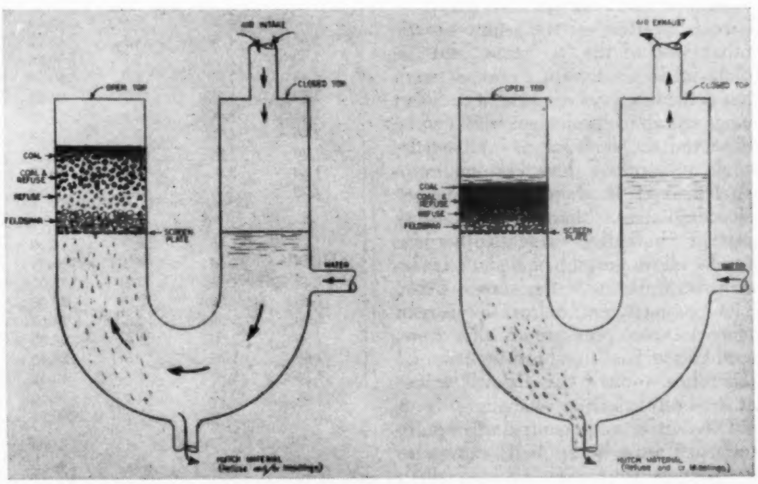


Fig. 2. Cross-section through a washing cell. Approximately two ft below the water level a flat screen with 5/8-in. holes supports a six-in. bed made up of 3/4 by 3-in. pieces of feldspar. Each of the cells is independently sealed below the screen plate level with separate withdrawal valves to remove refuse from the first two cells and middlings, which is recycled to the feed, from the third cell



As the coal progresses through the washing compartment of the jig it is stratified by a successive series of jigging impulses. The action can best be visualized by referring to the two simple "U" tubes shown above. Fig. 3 (left) illustrates the position of the water and coal in the jig at the end of the intake stroke. The air valves, by filling the air chest, have forced water through the "U" and upward through the screen plate, thereby distending the feldspar and also the entire bed of coal and refuse. Fig. 4 (right) illustrates the effect in the washing compartment at the end of the exhaust stroke. No air pressure is exerted on the water on the right side of the "U" tube and the material in the washing compartment has settled down, becoming a compact mass resting on the feldspar

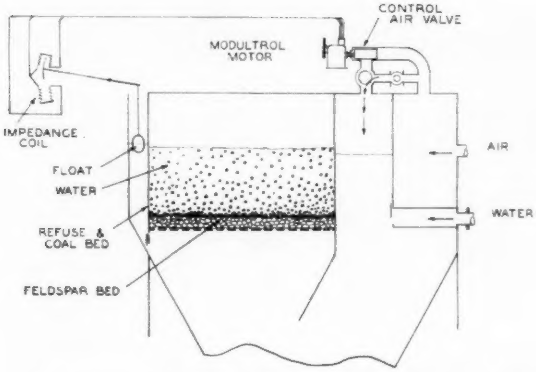
tained. Perforations in the plate are smaller than the feldspar and larger than the refuse to be removed, thereby retaining the feldspar as a permanent bed and allowing the refuse to continue its downward flow. The action can best be described by referring to figures 3 and 4, shown as two simple "U" tubes. Figure 3 illustrates the position of the water and coal in the jig at the end of the intake stroke. The air valves, by filling the air chest, have forced water through the "U" and upward through the screen plate, thereby distending the feldspar and also distending the entire bed of coal and refuse. At this time, the particles are separated in such a fashion that free settling can occur; then, as the air is cut off, the entire mass settles freely and the heavier particles, and consequently the higher ash particles, settle more rapidly and a specific gravity stratification is accomplished. Of course, this is not done in any single stroke but is accomplished by a series of impulses that eventually allow for complete stratification. As the air pressure is released and the mass begins to settle, stratified refuse at the bottom is also travelling downward and migrating through the distended feldspar and the perforated plate to the compartment below. This action continues at a diminishing rate until the mass has reached the position as shown in figure 4.

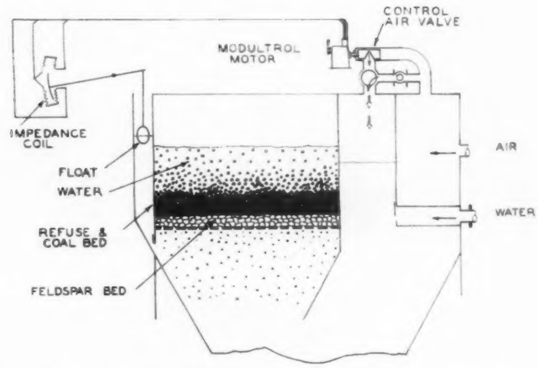
Figure 4 illustrates the effect in the washing compartment at the end of the exhaust stroke. No air pressure is exerted on the water on the other side of the "U" tube and the material in the washing compartment has settled down, becoming a compact mass on top of the feldspar. As can be observed the feldspar as well as the coal and refuse has become compacted, and it acts as a series of closed valves, thereby preventing further hutching which otherwise would allow the entire bed to travel downward through the screen plate. The compartment below the screen plate has no pressure at this time, enabling a free flow continuation of the refuse toward the drawoff valves at the bottom of the washer.

Obviously, some control of impulse intensity must be applied; otherwise it would be impossible to accomplish stratifications at different specific gravities or to cope with changing conditions such as feed quantities and qualities. Figures 5 and 6 illustrate the automatic control system as applied to this particular type of cleaning unit. These sketches represent a cross section of the washing compartment in each cell. Floats are suspended in wells on the outside of each cell. The bottoms of the wells are connected to the water compartments below the screen plates and the tops are open to atmosphere. As the bed in the washing compartment above the screen plates and the feldspar becomes more dense due to the accumulation of stratified refuse at the bottom, resistance to the upward passage of water increases. Since the wells are open to atmosphere and offer no resistance, the water level in the wells rises. This causes the floats to rise, changing the position of pivoting sensing devices operating in impedance coils, which in turn rotate compensating modulating motors connected to air inlet valves. The motors are modulating rather than strictly two position "on-off". They can make proper adjustments over the entire range, corresponding to

Table V. Float and sink analysis of various size fractions of the jig feed made in 1960

Specific gravity		% Wt.	Dry basis	Cumulative recovery		Cumulative reject (Sink)	
Sink	Float		% Ash	% Wt.	% Ash	% Wt.	% Ash
			Composite plus 8 mesh × 0 = 100% of feed				
	1.35	75.1	5.40	75.1	5.40	100.0	12.51
1.35	1.40	5.8	12.75	80.9	5.93	24.9	33.89
1.40	1.45	3.9	16.47	84.8	6.41	19.1	40.31
1.45	1.50	1.8	20.31	86.6	6.70	15.2	46.43
1.50	1.55	1.7	23.02	88.3	7.01	13.4	49.94
1.55	1.60	1.1	27.10	89.4	7.26	11.7	53.85
1.60	1.70	1.5	32.65	90.9	7.68	10.6	56.62
1.70	1.80	1.2	41.75	92.1	8.12	9.1	60.58
1.80	2.00	1.9	49.97	94.0	8.97	7.9	63.44
2.00		6.0	67.70	100.0	12.51	6.0	67.70
			+8 mesh = 41.1% of feed				
	1.35	78.5	5.89	78.5	5.89	100.0	11.17
1.35	1.40	6.2	13.37	84.7	6.44	21.5	30.46
1.40	1.45	4.0	17.60	88.7	6.94	15.3	37.38
1.45	1.50	1.4	22.45	90.1	7.18	11.3	44.38
1.50	1.55	1.3	25.12	91.4	7.44	9.9	47.49
1.55	1.60	1.1	27.98	92.5	7.68	8.6	50.87
1.60	1.70	1.2	33.91	93.7	8.02	7.5	54.23
1.70	1.80	1.0	41.64	94.7	8.37	6.3	58.10
1.80	2.00	1.6	51.17	96.3	9.08	5.3	61.20
2.00		3.7	65.54	100.0	11.17	3.7	65.54
			8 × 28 mesh = 48.7 of feed				
	1.35	76.6	5.16	76.6	5.16	100.0	11.97
1.35	1.40	5.1	13.08	81.7	5.65	23.4	34.28
1.40	1.45	3.7	16.24	85.4	6.11	18.3	40.19
1.45	1.50	1.8	20.50	87.2	6.41	14.6	46.26
1.50	1.55	1.7	24.06	88.9	6.75	12.8	49.88
1.55	1.60	0.9	28.48	89.8	6.97	11.1	53.83
1.60	1.70	1.5	33.70	91.3	7.40	10.2	56.07
1.70	1.80	1.2	41.79	92.5	7.85	8.7	59.93
1.80	2.00	1.9	48.71	94.4	8.67	7.5	62.83
2.00		5.6	67.62	100.0	11.97	5.6	67.62
			28 × 60 mesh = 6.2% of feed				
	1.35	58.9	4.50	58.9	4.50	100.0	21.35
1.35	1.40	4.7	13.44	63.6	5.16	41.1	45.50
1.40	1.45	3.6	16.55	67.2	5.77	36.4	49.64
1.45	1.50	2.9	20.06	70.1	6.36	32.8	53.27
1.50	1.55	2.5	24.63	72.6	6.99	29.9	56.50
1.55	1.60	1.4	28.45	74.0	7.40	27.4	59.40
1.60	1.70	2.5	33.48	76.5	8.25	26.0	61.07
1.70	1.80	2.1	42.41	78.6	9.16	23.5	64.01
1.80	2.00	3.9	51.56	82.5	11.17	21.4	66.12
2.00		17.5	69.37	100.0	21.35	17.5	69.37
			−60 mesh = 4.0% of feed				
	1.35	46.5	3.62	46.5	3.62	100.0	19.24
1.35	1.40	11.1	6.92	57.6	4.26	53.5	32.82
1.40	1.45	5.8	10.21	63.4	4.80	42.4	39.60
1.45	1.50	4.1	12.04	67.5	5.24	36.6	44.26
1.50	1.55	5.2	12.31	72.7	5.75	32.5	48.32
1.55	1.60	2.3	14.87	75.0	6.03	27.3	55.18
1.60	1.70	3.5	21.83	78.5	6.73	25.0	58.89
1.70	1.80	2.3	41.02	80.8	7.71	21.5	64.93
1.80	2.00	2.3	49.80	83.1	8.87	19.2	67.79
2.00		16.9	70.24	100.0	19.24	16.9	70.24





The automatic jig control system. Fig. 5 (left) illustrates a condition with a small amount of refuse accumulation. The float is at its lowest level and the control air valve is closed; only enough air is being admitted through a fixed opening to keep the bed alive enough for stratification. Fig. 6 (right) illustrates the opposite condition with the valve completely open, resulting in maximum bed and feldspar expansion and increased refuse withdrawal

changing pressures due to increasing or decreasing refuse accumulation.

Figure 5 illustrates a condition with a small amount of refuse accumulation. The float is at its lowest position. The control air valve is closed and only enough air is being admitted through a fixed opening to keep the bed alive enough for stratification.

Figure 6 illustrates the opposite condition with the valve completely open, resulting in maximum bed and feldspar distension and increased refuse withdrawal. Counterbalanced weights on the mechanism can be adjusted to make the floats more or less sensitive to pressure changes, thereby changing the gravity of operation. The air valves are so constructed that the ratio of intake to exhaust stroke can be altered in any desired fashion by moving the pistons forward and backward along the shaft individually. It is also possible to adjust the exhaust and intake ratio by screwing the shaft in and out of the eccentric which drives all of the units together. This is a very important feature since some coals require a short, rapid intake or distending stroke and a longer exhaust or free settling stroke.

Another control is also provided whereby the impulse rate can be altered. The jig at Badger is being operated at 59 strokes per minute. The quantity of water admitted to the compartment below the screen plate can also be adjusted. Once these manual adjustments—that is, of impulse rate, fixed air admission and water admission—have been made and the proper balance of the float mechanism established for a particular coal, the automatic features function in such fashion that quite a wide variation of feed tonnage and quality can be handled without constant attention by the operator. The entire washing plant, including the dense media section, needs little attention as illustrated by the fact that two inside men, an operator and an oiler-mechanic, are sufficient operating personnel.

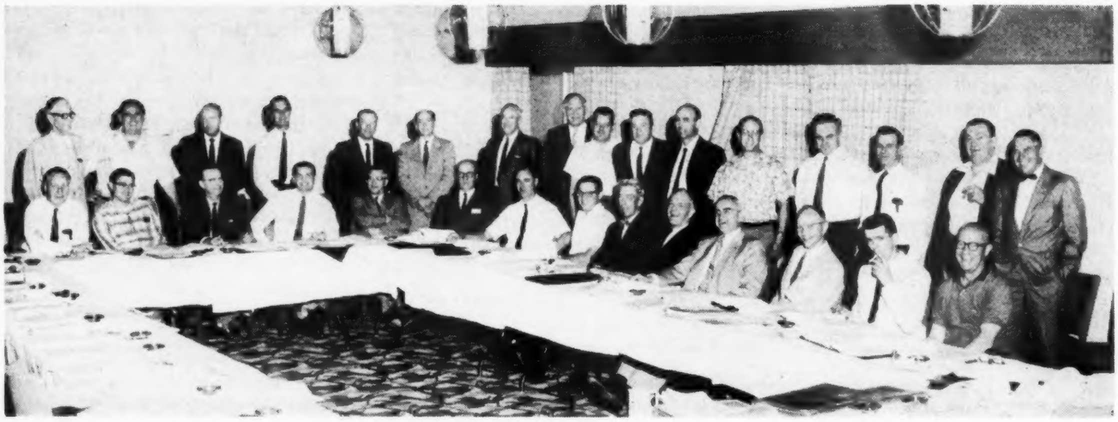
Some operating data previously published is shown in table IV, and some recent operating data is given in tables V thru VII.

Table VI. Summary of jig performance

Size	Raw coal ash %, dry basis	Cleaned coal ash %, dry basis	Ash reduction %	% Recovery (from raw coal curve)
+ 8 mesh	11.17	9.30	1.87	96.9
8 × 28 mesh	11.97	8.89	3.08	95.1
28 × 60 mesh	21.35	7.91	13.44	75.1
60 mesh × 0	19.24	7.12	12.12	79.4
Composite + 8 mesh × 0	12.51	8.71	3.80	94.5

Table VII. Screen analysis of jig feed and product made in 1960

Size		% Wt.	Dry basis	Cumulative Results			
				Retained on screen in Column 2		Passing screen in Column 1	
Passing	Retained on		% Ash	% Wt.	% Ash	% Wt.	% Ash
Feldspar Jig Feed							
	8 mesh	41.1	11.01	41.1	11.01	100.0	12.51
8	28 mesh	48.7	11.96	89.8	11.53	58.9	13.56
28	60 mesh	6.2	21.84	96.0	12.19	10.2	21.19
60 mesh	0	4.0	20.18	100.0	12.51	4.0	20.18
Feldspar Jig Cleaned Coal							
	8 mesh	22.2	9.30	22.2	9.30	100.0	8.71
8	28 mesh	57.4	8.89	79.6	9.00	77.8	8.54
28	60 mesh	11.0	7.91	90.6	8.87	20.4	7.55
60 mesh	0	9.4	7.12	100.0	8.71	9.4	7.12
Feldspar Jig Refuse							
	8 mesh	44.3	43.76	44.3	43.76	100.0	36.78
8	28 mesh	44.2	34.95	88.5	39.36	55.7	31.23
28	60 mesh	8.3	16.51	96.8	37.40	11.5	16.94
60 mesh	0	3.2	18.05	100.0	36.78	3.2	18.05



1960 AMC Convention and Exposition

Program developed for Las Vegas, October 10-13

Meeting in Las Vegas, Nevada, on June 15, State and District Chairmen of the Program Committee for the 1960 AMC Mining Show laid plans for the convention sessions to be held in conjunction with this year's mining equipment exposition.

The committee, under Chairman Oscar A. Glaeser, reviewed the many worthwhile suggestions submitted by mining men throughout the industry, and selected subjects and speakers to deal with problems of major interest. Prominent members of the House and Senate will join with mining leaders in discussing matters of broad policy, while qualified operating and technical men will present new developments in mining practices and equipment.

The program is designed to convey the greatest amount of information that can be presented during the four days of the meeting. Two half-days have been left completely open, to allow additional time to study the exhibits of new and improved mining machinery and supplies and to discuss individual problems with manufacturers' technical representatives.

The convention program will include discussions on national mineral policies; labor and management problems; taxation; gold, silver and monetary policies; public land administration; the economic outlook for the minerals industries; management engineering; underground and open-pit mining developments; exploration and geology; milling and metallurgy; health and safety, and mining problems in general. Included will be symposiums on subjects of special interest, such as have been so successful at past AMC conventions.

The exposition will bring together the largest and most comprehensive displays ever shown to the metal mining and industrial minerals industries. Some 200 manufacturers are completing plans for exhibiting a wide range of products. The educational value of the exposition and its effectiveness in stimulating adoption of improved operating techniques and equipment — leading to more efficient, safer, and more economic operations — cannot be overestimated. The exposition and convention sessions will be held under "one roof" — in the air-conditioned comfort of Las Vegas' new Convention Center — assuring optimum use of convention goers' time.

A special program is planned for the ladies — including an "extra special" luncheon and fashion show, and a reception and tea at the beautiful home of Mr. and Mrs. Joseph W. Wells, of Las Vegas. There will be time available for taking in the sights, for shopping, and for just relaxing in the sun.

Following the convention and exposition, two special trips are planned; one by air to the mine, mill and smelting operations of Kennecott Copper Corp. near Ely, Nev., and the other by bus to the nearby Apex plant of U. S. Lime Products Division; Stauffer Chemical, American Potash & Chemical and Titanium Metal plants of the Basic Management complex; and Blue Diamond Co., division of the Flintkote Co.

Preceding the program meeting, the various arrangements committee chairmen met with AMC Western Division Chairman John C. Kinnear, Jr., and completed plans which will assure all those attending a memorable visit to Las Vegas.

Because of the top-flight entertainment featured in Las Vegas' many fine resort hotels, no official AMC evening functions will be held. For the convenience of Mining Show visitors, a central bureau will be set up at which reservations can be made for both dinner and midnight shows at the various hotels.

The heavy advance registration indicates a capacity crowd. If you haven't already made hotel reservations, better forward your request promptly to the AMC Housing Bureau, Convention Center, Paradise Road, Las Vegas, Nev.

Western phosphate mining

All but one of the major mines supplying ore to elemental phosphorous plants in the West are open pits, since the economics of elemental phosphorous production generally will not permit underground mining. Because of faulting and local grade changes of the ore beds, very careful mining control is required

By O. E. POTHIER
Director of Mining Operations
J. R. Simplot Co.

PHOSPHATE deposits in the West are situated within portions of Idaho, Montana, Utah and Wyoming. They are reported to contain over 60 percent of the Nation's reserves.

These deposits have been known for over 60 years, but it has only been the last 15 years that widespread interest has been shown in them. Development was slow until after World War II. Since that time, production has increased from a few hundred thousand tons to two and one-half million tons in 1958. Even though the manufacture of fertilizers has increased several times, the major increase in tonnage is due to the construction of three electric furnace plants, which require about 1,500,000 tons of ore a year. This tonnage was further increased when Central Farmers Fertilizer Co. at Georgetown, Idaho, started production in July of last year.

Among the major operators in the western phosphate fields is Montana Phosphate Co., located at Garrison, Mont. This operation is primarily underground, but at the present time, about 20 percent of production is open pit. Victor Chemical Co., located at Silver Bow, Mont., produces elemental phosphorus. Victor's mines are a few miles south of Silver Bow.

The major increase in tonnage since World War II has gone to electric furnace plants. Pictured above is the 35,000 kw facility of Central Farmer's Fertilizer Co. at Georgetown, Idaho, which came into production during 1959

Typical of equipment used in overburden removal is this 24-cu yd scraper. Note the ripper attachment on the "pusher" tractor

J. R. Simplot Co., has open pit mines near Monida, Mont., Fort Hall, Idaho, and Soda Springs, Idaho. Monsanto Chemical Company's open pit mine at Soda Springs, Idaho supplies ore for electric furnace feed. Central Farmers operation is also an open pit supplying ore for elemental phosphorus and fertilizer production. San Francisco Chemical Co., Montpelier, Idaho, and Sage, Wyo., has both open pit and underground mines. The ore is used for the manufacture of fertilizers. Bunker Hill recently announced its intention to enter the field. Its mine is located near Elliston, Mont., and its plant at Kellogg, Idaho.

Commercial Beds are in Phosphoria Formation

The Phosphoria formation is made up of a number of beds of varying grades and thicknesses of phosphatic material. It is not uniform throughout its area; for example, in parts of Montana the high grade member is only three ft to six ft thick and assays 30 to 33 percent P_2O_5. The phosphatic shales are not present in sufficient quantity to be mined. In terms of tricalcium-phosphate or bone phosphate, the conversion factor is 2.18 to 1 or 33 percent P_2O_5 is 72.05 percent tri-calcium-phosphate.

In Idaho, at the Fort Hall mine, strategically the same bed exists. In addition, this is overlaid by an average of 21 ft of phosphatic shales averaging 24 percent P_2O_5, plus another 25 ft of shale averaging 16 to 18 percent P_2O_5. Further east in Idaho and Wyoming the above beds are present in different thicknesses with still another high grade member at the top of the formation.

For nomenclature purposes, fertilizer grade ore is that normally mined from the high grade bed. The analysis is usually above 30 percent P_2O_5 and is called phosphate rock or main bed. Twenty-two percent to 30 percent material in the shale section is referred to as high grade shale or furnace shale and all other shales used, or stockpiled, are called low grade shales.

These beds are mined in various combinations or units depending on the use intended. Simplot, at its Fort Hall operation, selectively mines the lower high-grade bed for production of phosphate fertilizers and phosphoric acid. High-grade shale is mined for direct feed to electric furnaces for production of elemental phosphorus, and the low grade shales are stockpiled for future beneficiation.

Monsanto mines all three members and blends them for furnace feed. The Conda Idaho mine, operated by Simplot, and San Francisco Chemical mine high-grade rock for fertilizer production and the high-grade shale for beneficiation to fertilizer grade material.

Most Mining is by Open Pit Methods

All operations differ somewhat and the nature of the deposit dictates the mining method that is in use. However, if the deposits approach a dip slope a certain amount of open pit mining can be done. Generally the economics of elemental phosphorus production will not permit underground mining and with one exception, all mines supplying these plants are open pit.

All the major open pit mines, presently four in number, are in southeastern Idaho and southwestern Wyoming. The phosphoria in this area has been folded, faulted and then eroded, exposing the phosphate formation in narrow bands, generally trending North-South along the flanks of folds or along the faulted areas. The intensive faulting has made mining, at times, quite difficult.

In order to better understand the mining, a brief description of the Phosphoria should be given. It is made up of two entirely different type sections. The upper member is called the Rex chert, which is now being reclassified. It is normally over 400 ft thick. In the vicinity of the Fort Hall mine and in other localized areas this is not a true chert, but more of a cherty shale. However, generally it is a hard black chert with some interbedded lime and shale members.

Below and conformable to the Rex, is 75 to 180 ft of phosphatic shale, brown banded siltstones and thin beds of lime. From this section, called the phosphate shale member of the Phosphoria formation, the lower 20 to 30 ft is mined for ore. The footwall is limestone.

In places where the hard chert exists, open pit mining is presently confined between the Rex chert and the footwall lime. In areas of the cherty shale it is possible to strip a portion of the Rex; the amount is determined by the thickness of the underlying ore and the economics of the particular operation.

Winter Slows Mine to Plant Shipments

All the open pit mines generally use the same type of equipment. No blasting is required in the Phosphoria shale member. Individual ore transportation problems vary, depending on the location of the plant and the use for which the ore is intended.

Simplot has been in the phosphate mining and processing business for 13 years. It is operating what is now the largest open pit phosphate mine in the West, and its operation is quite typical of the industry.

Simplot mines over 1,000,000 tons a year of combined phosphate rock and shale for manufacture of various fertilizers at its Pocatello, Idaho, plant and furnace feed for Food Machinery & Chemical Corp. electric furnaces, also located at Pocatello. The ore is shipped 30 miles by rail from the mine to the two plants. It is necessary to ship the major portion of this tonnage from May 1 to October 1, because of the availability of railroad cars and rather severe winter conditions. Stripping and stockpiling is carried on in the remaining seven months. The high grade ore is four to six ft thick and is quite uniform in grade, but the shale is irratic due to the degree of alteration and the nonuniformity of deposition. Changes can occur within a few feet.

Minimum Permissible P_2O_5 Content

The mine maintains as high a grade of phosphate rock or main bed as possible, normally it is 32 percent. The shale must average 24 percent P_2O_5 with the lower limit 22 percent. All ore is shipped from the mine by railroad at the average rate of 10,000 tpd on one 10-hour shift. Each 20 railroad cars of shale, regardless of weight, is an assay unit and must not be less than 22 percent P_2O_5. Each 300 cars is a lot and must average 24 percent P_2O_5. In order to maintain a uniform grade, close control is very important. All ore passes through an automatic sampler as it is loaded.

The mining panels are selected from results of dry rotary drilling, which gives grade by assay and structure by logging. Long range exploration drilling is spaced 100 ft on dip and 400 ft on strike, while drilling for panel selection is somewhat closer, depending on the uniformity of the results. Normally two or three panels are selected that, when mined and blended, will give the tonnage and grade desired. The mine is located along six miles of the outcropping Phosphoria so panels are also selected to balance the length of haul.

Waste material is removed by two 18 cu yd single engine scrapers and two 24 cu yd twin engine scrapers which haul a maximum of 1800 ft to the waste dump. Model D-9 Caterpillar tractors with rippers are used for push loading and loosening the cuts. In the harder unaltered and sometimes lime bearing zones, 2½ cu yd shovels are used to load the material into 17 ton end-dump trucks and 26 ton and 40 ton bottom dump wagons. The haul roads and waste dumps are maintained at all times by motor graders and dozers. Tire wear and maintenance costs have been improved by this practice.

Advantages of Twin-Engine Scrapers

Two and one-half cu yd shovels are used for all shovel work. They may not be the best for any particular job, but they are best for the several jobs they are required to do. The bucket is large enough to give a fair capacity and small enough to permit selective mining.

Considerable mobility is achieved by equipment such as the twin-engine scrapers. As long as weather conditions are dry there is no great advantage to their use, but when the pits are wet they are able to continue to operate when the single engine scrapers are idle. Also, they are able to self-load from stockpiles without tying up two pieces of equipment.

Open pit phosphate mining with 2½ cu yd shovel. The bucket is large enough to give a fair capacity and small enough to permit selective mining

When the panel has been stripped to the low grade shales, it is drilled again on 50 ft centers. The low grade shales, high grade shales and the main bed is sampled and mining control maps are prepared. Drill holes are platted and sections and grade isopacs are made at ten ft depth intervals. Copies of the maps are carried by the pit foreman and used for mining control. Grid markers are set on the pit boundaries as an aid to location.

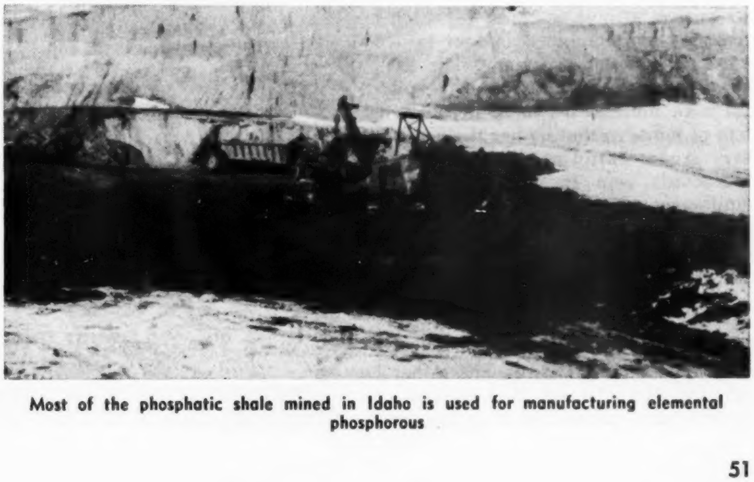
Next, the low grade shales are mined, usually by 2½ yd shovels, and stockpiled on top of the waste dump for future reclaiming. It would be possible to remove the shales by scrapers at a lower cost, but extensive faulting and grade changes make this undesirable if all of the available ore is to be recovered. Many times it is possible to recover and ship a section of the low grade shales that may locally carry good values.

A limestone bed three ft thick, called the false cap rock, is next removed and wasted. The high grade shales are then mined by 2½ cu yd shovels and hauled to the bins in 26 ton and 40 ton bottom-dump wagons for crushing, automatic sampling and loading aboard railroad cars. Below these shales another three ft bed of limestone, known as the cap rock, is wasted and then the main bed is mined, also by 2½ cu yd shovels and crawler tractors. The tractors are necessary to "root" the ore out of the irregular footwall and pile it for loading. They are also used to sweep the top of the main bed clean, before mining, to eliminate contamination as much as possible.

Faulting has Complicated Mining

After production is started in a panel, there may be one or a combination of three operations going on at the same time; namely, stripping, shale mining and main bed mining. This is due to extensive faulting. Some displacements in the pits are as much as 30 or 40 ft, and in many instances thrust faults have cut the ore off or caused parts of it to be repeated two and three times.

The pit floors are carried as level as possible and roads are planned and extended into the bottom of the pit as



Most of the phosphatic shale mined in Idaho is used for manufacturing elemental phosphorous

mining progresses. In most instances the footwall is very irregular and so the main bed has to be mined after each bench is taken out. This is especially true where the ore has a steep dip. If this were not done, it would be impossible to later recover the ore.

Haul roads from the pits are maintained at all times. They are not of special construction, except for surfacing with chert, because as the pits get deeper changes are made to give more favorable grades. Some of the pit faces are now approaching 150 ft in height and are benched for safety reasons. The haul roads are continually watered and calcium chloride is applied at least twice during the mining season.

During the period of the year when ore is not being shipped, a 150,000 to 200,000 ton stockpile of shale is built near the loading site. A great many times during the mining season short delays occur in the pits and as a result, railroad car loading is interrupted. A twin scraper can self-load from the stockpile and maintain uninterrupted car loading. A scraper is also placed in stockpile at the beginning of each day with the result that car loading can start immediately at full capacity without having to wait for the first trucks from the pit.

Close Control of Ore Grade

The ore is dumped into two 65-ton bins from which it is fed to a 42 in. belt by two pan feeders that can be operated individually or together. The ore passes over a three in. vibrating grizzly where the coarse can be discarded as low grade or passed through a jaw crusher, as desired. It then goes to an automatic sampler where two percent of the flow is cut. This two percent is led over a screen and through a hammer mill and then to a secondary and tertiary cutter. The rejects are fed back to the main stream. A sample is taken for each five cars and combined in four samples for one 20-car sample. The assay is made immediately and the pit foreman notified by radio or a system of lights so that he has the necessary grade control at all times.

Records kept for each piece of equipment to give operational data include a breakdown of all time, location worked, and work done. Repairs are separated into maintenance repairs and major repairs. Costs are carried against the major classifications of material stripped and mined on the location. Records are rather detailed but it is felt that complete records are necessary for present evaluation and forecasting.

Production of phosphate products is increasing very rapidly in the West, and with new companies entering the business and the existing companies increasing their capacity, competition is strong. The last 15 years has seen a large part of the more shallow ores being mined. Open pit reserves are large but someday all production will be from underground mines. The necessity of beneficiation is being recognized more all the time. A few of the operating companies have installed plants and new operations are making it a part of their program. It is the writer's opinion, that in order to utilize all the values and prolong the life of the mines, that before too long, a mill will be a part of each operation. There are still many problems to be solved but it looks encouraging.

The phosphate business, in the West, is still in its infancy and appears to have a long life ahead of it.

Trailing Cable Life Can be Improved

AMC Committee on Underground Power launches campaign to better performance of mine trailing cable

TRAILING cable, one of the most important "pieces of equipment" used in modern coals mines, is by definition of the U. S. Bureau of Mines, "a flexible cable or cord by means of which portable, semi-portable, and mobile mine equipment may be connected to a source of electrical energy."

The purpose of this report is to propose a study of trailing cables to improve safety and to reduce operating costs. Obviously, improvement in safety and reduction of operating costs are related and are important factors in the efficient operation of a mine. Improvement in safety makes possible a decrease in a mine's accident rate, a decrease in costly lost time man-hours and an increase in output tonnage. The mine and the equipment in it will be subjected to less damage. Better equipment and maintenance will improve safety. All these factors reduce operating costs and increase profits.

To attain the goal of improved safety and reduced operating costs by means of a study of trailing cables, it is necessary to recognize and to understand certain fundamental facts.

The rigorous electrical, mechanical, thermal, and chemical service conditions under which trailing cables operate, require a careful choice of conductor, insulating, and protective covering materials as well as a choice of the best geometric cable design. By the use of modern insulation and jacket materials, better knowledge of conductor strandings, and ingenious cable construction, good trailing cables are available today. It would be foolhardy to say that cable manufacturers have reached the ultimate in the design and manufacture of trailing cables. However, it certainly is correct to state that trailing cables have been vastly improved over those of yesterday.

Trailing cables are no different from other mine equipment in that there are operating conditions that exceed their service limitations. They cannot be made as tough as a steel pipe because trailing cables are coiled, or reeled and unreeled, and must have a high degree of pliability. There are limits to the amount of tension to which a cable can be subjected without breaking the conductors. There are limits to the diameter to which a trailing cable can be bent and the number of times it can be bent without causing cable failure. There are limits to the amount of current a cable can transmit without overheating, resulting in excessive deterioration of the insulation and jacket which effectively shortens cable life.

Even with the use of the most modern of cable materials and improved cable designs, it is debatable whether trailing cables can more effectively withstand the high temperatures, sharp bends, excessive tensions, twisting, kinking, water, and runover conditions which are unfortunately altogether too common in mine service, without improved equipment design and improved mine cable handling procedures and maintenance.

Cable Dependability Becoming More Important

Constant attention must be given to ways and means for improving maintenance because of the constantly increasing complexity of new equipment and systems. Production time can be shortened considerably by the failure of a trailing cable. Thus it is vital to a profitable operation that cables be given the same high degree of attention as is given other important parts of machines

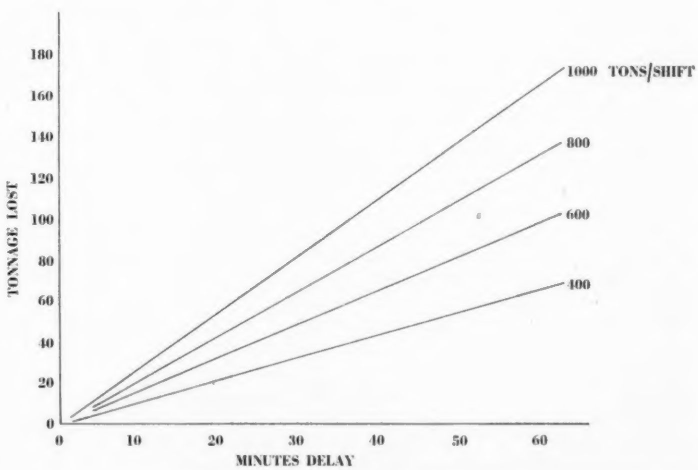


Fig. 1. Tonnage loss for various time delays

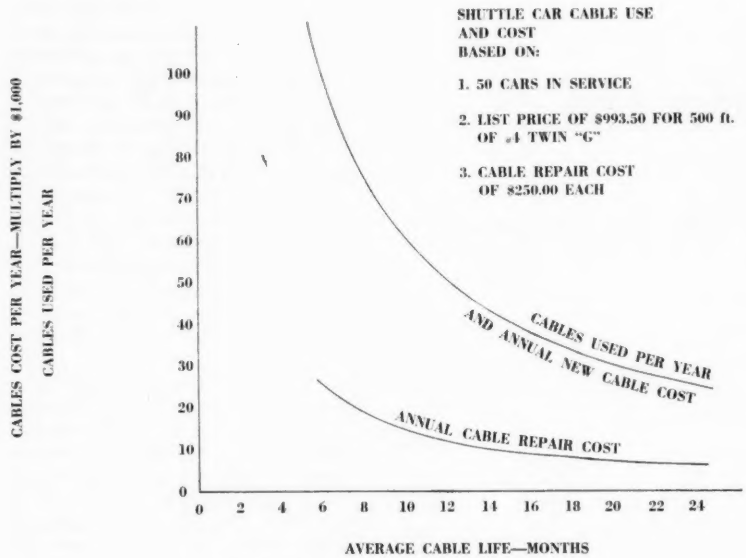


Fig. 2. Cable costs as affected by cable life

and systems. That means that cables should always be included in a check-up before machines begin operation. The inspection should be regulated on a specified time basis after so many hours of operation and not be a haphazard program.

Maintenance of the machines should require checking of the tensions applied to the cables and improperly operating reeling devices. Sections of the equipment which permit the cable to be scored should be repaired. Jammed sheaves should be freed.

Trailing cable inspection and maintenance should be improved. Cables should be examined for gouges, cuts and punctures, excessive abrasions, indications of overheating, burned spots, broken conductors, and poor splices.

Faulty cable can lower safety limits, as well as increase operating costs and decrease output tonnage.

Good Splices Pay Off

For many years the American Mining Congress, in cooperation with other organizations, has pointed out the advantages of better splicing and repairing techniques. To some extent the reports of the various committees have been ignored. This is foolhardy. A poorly repaired cable can cause more failures in the same length. As an example, failure of a poor splice on a reel will change the cable in three to six other spots. This means further loss of tonnage and an increase in operating costs.

Some mines have realized the need for better splicing and repair techniques. One mine has reported their practice of vulcanizing splices at the end of the shift after the fault occurs has decreased their cable cost by 50 percent. Certainly such a saving is worth while.

Indications in recent years are that there has been an increasing number of fires which have been attributed to cable failures. Although modern trailing cables are flame-resistant and are required to meet the flame tests of the Bureau of Mines' Schedule 2-F, this characteristic is worthless if poor splices are permitted which constantly fail and create electrical fires.

What Needs to be Done?

A better understanding of the economics involved in trailing cables is needed. Figure 1 shows tonnage lost for time delays up to one hour for sections producing from 400 to 1000 tons in six hours and figure 2 shows shuttle car cable use and cost based on 50 cars in service. It must be realized, of course, that data will vary between individual mines; however, it is suggested that similar data be prepared by each mine and used to evaluate direct and indirect cable costs.

A cable inspection and maintenance program should be a vital part of any operation. Relatively few mining companies, however, follow a practice of inspecting cables in a manner similar to machine inspection. For many years it has become general practice and more or less habit to inspect machines to determine if lubrication is satisfactory. The next step is to see if the machine will operate properly and then, it is put into operation.

Some mining companies have machine inspection forms or cards on which the machine operator is required to check-mark each item as he makes his pre-shift inspection. Cable is generally included as an item to be checked, but in most instances this includes a visual inspection of the sections of cable exposed at the time of inspection, especially if the machine is of the cable-reel type. It is probable that the cable will contain temporary splices, many of which will be concealed on the reel unless the cable is removed for its full length to permit a more complete visual inspection. Faulty splices or serious fractures in the cable are generally not detected until failure occurs and operation is interrupted.

In many instances, visual inspection of the trailing cable will reveal faulty locations that may breakdown during operation and these can be repaired beforehand. However, this type inspection will not reveal internal weaknesses in the insulation and conductors. Such conditions can be detected by electrical tests such as a megger test for voltage and insulation resistance. Equipment to perform these tests may need slight modifications for mine use. These particular operations should be performed at the repair shop underground or on the surface.

Fluoroscope and X-ray can be used for detecting defects in the trailing cable, especially the location and condition of the conductor. A few manufacturers of fluoroscopic equipment have been contacted by the committee and advised of the problem and conditions. This machine should be directed at the cable from a vertical and horizontal plane in order to obtain a good cross-sectional view of the cable under inspection. With such an instrument the cable could be inspected foot by foot throughout its length.

It is possible that a device can be developed to continuously monitor the condition of the cable while the machine is operating.

Every time a failure occurs in a trailing cable, production is interrupted, and the amount of down-time charged to the operation is increased. In most instances, these failures could have been prevented if cables were inspected regularly for defects or op-

operating conditions corrected to prevent serious abuse to the cable. Failures in trailing cables have initiated many fires and explosions in underground coal mines resulting in injury or loss of life. Considering the loss of production and money to the mine operator resulting from cable failures, it appears that considerable saving can be realized by proper maintenance of the trailing cable. It is believed a good inspection and maintenance procedure will assist in obtaining this objective. With this in mind, the committee offers the following recommendations for inspection and maintenance of trailing cables.

1. Make regular inspections each shift.
2. Make repairs where necessary before placing equipment in operation.
3. Give special attention to splices.
4. Record number of temporary splices. (Recommend no more than five temporary splices).
5. If machine is equipped with a cable reel, check operation of reel, tension by pulling cable from reel under load, operation of traverse, sheaves, and cable guides.
6. Trailing cables of cable reel equipment should be rechecked after machine has been in operation under load to determine if splices or faulty spots show indication of excessive heat.
7. Check overload protection provided for trailing cables at the power tap.

Standby cables should be provided near the mining operations to permit replacement of faulty cable. Faulty cable should be sent to the repair shop.

Shop procedure should incorporate the following:

1. Cables returned to the shop for repair should be inspected visually and bad sections cut out and discarded.
2. Good appearing sections should be checked with a high voltage imposed between conductors and between conductors and ground — a potential of 1000 volts d-c is suggested for testing 600 volt rated cables. Insulation resistance tests should also be made.
3. Splices should be made in a permanent manner in accordance with recommended splicing procedure.
4. The repaired cable should be rechecked electrically.

Questionnaire to be Used to Obtain Cable Service Records

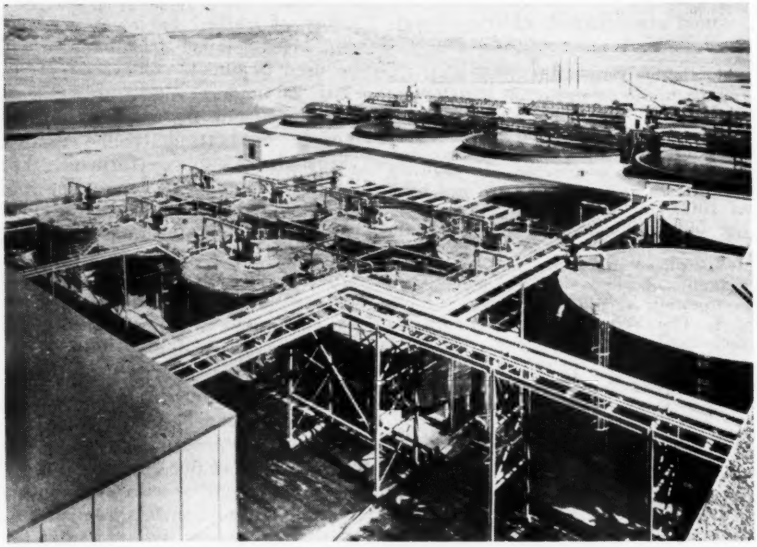
Trailing cables are a vital "link" in underground electrical systems. With increased mechanization it has become even more necessary to concentrate on the strengthening of this "link". Improved cable performance will reduce operating cost and improve safety. However, before improvements in handling techniques, cable design, machine design and maintenance programs can be intelligently recommended an accurate up-to-date appraisal must be made of present day cable performance. The committee preparing this report is directing an appeal to mining men for their cooperation in a program of assembling information on cable performance. This pertinent information can then be coordinated, cataloged and analyzed by the committee to determine what measures are necessary in extending the service life and safety of trailing cables.

A brief detailed questionnaire will be used to obtain cable service records in underground mines. Data obtained from these questionnaires will be used to determine various yardsticks of cable performance. For example, number of temporary and permanent splices vs. cable life, cable splices per ton, and tons produced per cable dollar costs might be used. This information will be made available to the mining industry because the Committee would "like to know what others are doing."

The primary objective is to draw some helpful conclusions on present cable performance. Such a study will be useful to the mining man — because it will enable him to compare his cable practices with other mines and make improvements as required; to the equipment manufacturer — because it will provide valuable information on how successfully the cable has been applied to the machine, thereby leading to any desirable improvement; and to the cable manufacturer — because it will reveal to his mine cable specialists any inherent cable weaknesses and enable him to correct them. In each instance, the benefits will accrue to the cable user.

Note: The AMC Committee on Underground Power will be happy to hear from companies willing to assist in its trailing cable life improvement program. Just write the American Mining Congress, Ring Building, Washington 6, D. C., and ask for the Cable Questionnaire Instruction Booklet.

Improved cable performance will reduce operating cost and improve safety



In the extraction circuit (foreground), the aqueous feed liquor flows by gravity from one stage to the next because of a one ft drop between stages. Solvent is advanced between stages by polyvinyl chloride lined pumps

Performance of the Kermac Solvent Extraction Plant

Its record of smooth operation is a demonstration of the practicability of solvent extraction as a useful mineral industry process

By WAYNE C. HAZEN
Manager
Mineral Development & Research
Kerr-McGee Oil Industries, Inc.

THE 3630 tpd uranium recovery mill of Kermac Nuclear Fuels Corp. at Grants, N. M., began operating in the fall of 1958. This mill is an acid leach solvent extraction plant using sulfuric acid to dissolve the uranium, thickeners and classifiers to separate the liquids from solids, amine solvent to recover the uranium from the clarified liquor and ammonia to precipitate yellow cake.

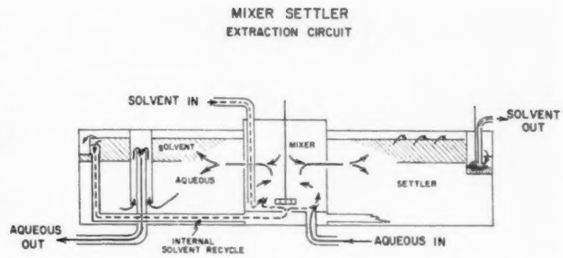
The ore feed is a grayish, medium-grained sandstone with some calcite cement and some organic material probably of asphaltic origin. The uranium is associated with the organic as a coating on the sand grains. There is vanadium present in amounts up to 0.5 percent as well as a few hundredths of a percent of molybdenum. The ore grinds easily to the natural grain size, which is sufficient to expose the uranium to the acid and obtain good leach extraction.

Flow Sheet Evolved From Two-Year Study

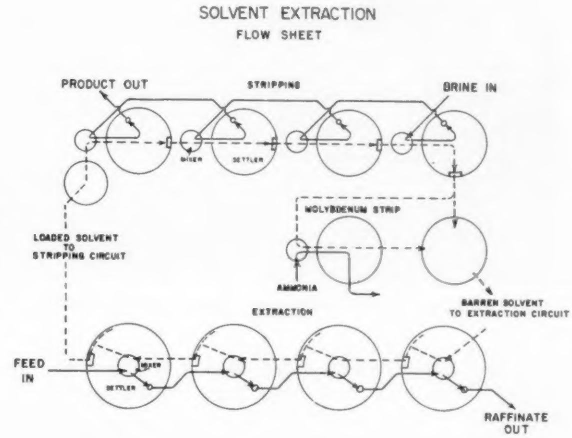
The choice of flow sheet for the mill was made on the basis of metallurgical studies carried on over a two year period and included operation of a one tpd pilot plant at Kerr-McGee's Research Laboratory at Golden, Colo. Much of this metallurgical work was concentrated on the solvent extraction part of the circuit, once it was decided to use acid leaching instead of a carbonate circuit.

Since this article is concerned with the performance of the mill, it is of interest to describe the development work on solvent extraction which led to the design of the full scale units. The first decision to be made concerned the choice of solvent, whether to use organic phosphate as used in the Kerr-McGee mill at Shiprock, N. M., or whether to use an amine because of the lower cost to be expected through its use. This lower cost was anticipated because: (1) no reduction of ferric iron is required for amine solvents; (2) salt brine can be used for stripping; (3) the amines can be used at lower strength than the phosphates resulting in a lower cost per gallon of made-up solvent in the circuit. Primarily for these reasons the amine system was chosen.

The question of whether to use a secondary or tertiary amine was decided in favor of the tertiary. Although the secondary amines are particularly suited for use with acid leach liquors containing molybdenum, they suffer from chloride sensitivity. Since it was expected that tailings liquor would be recirculated as wash water to the thickeners, the chloride



Each stage of the extraction circuit consists of a wooden settler with a stainless steel mixing tank in the center. Organic solvent and aqueous are mixed in the center tank and discharged through holes into the settler where they separate



Flowsheet of Kermac's solvent extraction plant

content of the plant streams would build up to a point where it could interfere with the extraction efficiency. In addition, the tertiary amine has higher loading capacity.

Scale-Up from One-TPD Pilot Plant to 3600-TPD Mill

Although the chemical problems were the subject of considerable laboratory and pilot plant study, they were clearly answered by the testwork. More difficult to study were the problems associated with establishing the design information since the scale-up factor was approximately 3600 to 1 from testwork to big plant.

These problems were concerned with such considerations as settler area requirements, residence time in the mixers to achieve equilibrium, agitation intensity, emulsion formation and accumulation, loss of solvent by entrainment in raffinate, operational stability, organic recycle, etc. These are as closely connected with design of equipment as with the chemistry of the process and are, of course, vital to satisfactory performance of the final plant.

A piece of equipment for studying these subjects was developed and used in the pilot plant for nearly a year. It consisted of a four stage mixer-settler system for extraction, four stages for stripping and a molybdenum stripping stage. All units were built of plastic for visual observation of the phase separation and interfacial accumulation. Mixers were designed for agitation intensity studies, and all units were equipped to recycle organic from the settler back to the mixer for control and measurement of the ratio of organic to aqueous volumes independent of the liquor feed rate.

It has been concluded from extensive work with this unit that it is a satisfactory way to obtain design data for scale up to large sizes. It was also concluded by comparison of results in this unit with batch laboratory tests that design data obtained from batch testwork is a shaky foundation for scaling up to full size operating units.

Gravity Flow of Feed Liquor Between Stages

The Kermac solvent extraction plant contains two identical circuits in parallel to achieve the desired capacity. Each circuit consists of four stages for extraction of uranium from the clarified feed liquor, four stages of stripping, where 1.5 Molar sodium chloride solution strips the uranium from the loaded solvent, and a one stage molybdenum stripper. In this latter stage, a portion of the barren solvent is treated with soda ash and ammonia to clean out the molybdenum, which is not removed by the sodium chloride brine stripping. The brine strip solution is sent to yellow cake precipitation.

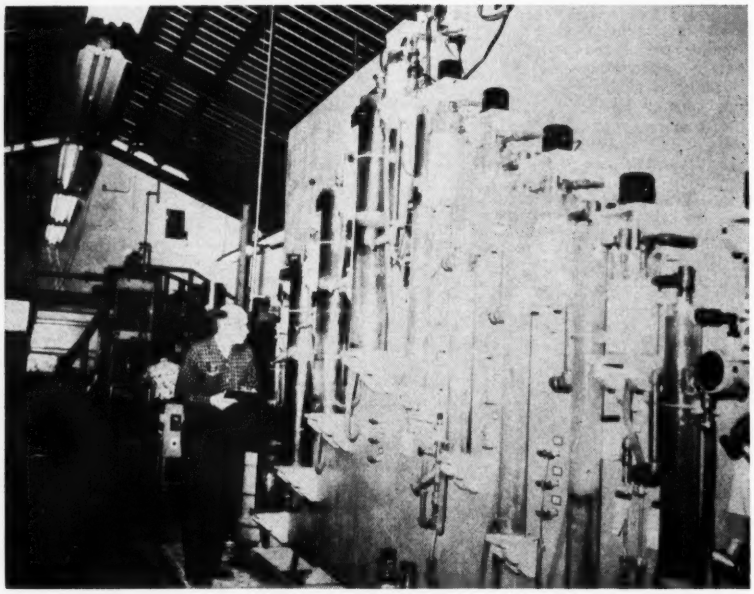
In the extraction circuit, the aqueous feed liquor flows by gravity from one stage to the next because of a one ft drop between stages. The solvent is advanced between stages by PVC (polyvinyl chloride) lined pumps. Each stage consists of a 40 ft diam by 9 ft deep wooden tank as a settler, with an 8 by 9 ft stainless steel tank as a mixer directly in the center and resting on the bottom of the settler. The organic solvent and aqueous are mixed in the center tank and discharged through holes in the side into the settler where they separate. The aqueous flows through outlet pipes in the bottom to the next stage, while the solvent overflows a circular launder, is collected in a sump and pumped up to the preceding stage.

Solvent Recycled in Settlers

In each settler, there is a separate submerged launder four in. below the surface which leads solvent through ducts back to the mixer to provide an internal solvent recycle through the pumping action of the mixer turbine-type impeller. This internal recycle is necessary to ensure that the volume of solvent in the mixer is always in excess over the aqueous. This improves phase separation and decreases entrainment losses.

The loaded solvent from the extractors is pumped to a holding tank where any carry-over of aqueous can settle out, after which it flows by gravity through the strippers. The brine strip solution is pumped "uphill" by PVC sump pumps. The mixer settlers in the stripping section are not combined as in the extractors, but consist of 22 ft diam by 8 ft deep wood tanks for settlers and 8 by 9 ft wood tanks for mixers. It was undesirable in the stripping section to have the mixers set inside the settlers because of their relative sizes and because no internal solvent recycle is required since the organic is always in excess. In each settler the organic is collected by a wooden launder set straight across the tank diameter. The chloride brine is discharged from the bottom of the settler into a small sump tank set at the same elevation as the settler. Sump pumps advance the brine only after it reaches a certain level, thereby holding a constant depth of strip liquor in the settler.

To describe the performance of this equipment, it is convenient to divide it into chemical results and what might be termed operational prob-



Pilot plant solvent extraction unit used in development of the Kermac flow sheet

lems. As far as extraction of uranium is concerned, the results have been uniformly excellent. The raffinate has been maintained for months at 0.001 grams U_3O_8 per liter or less from feed liquors of one gram per liter which corresponds to 99.9 percent efficiency.

The consumption of sodium chloride in the stripping circuit is 3.5 lb per pound of uranium recovered under conditions which give adequate stripping and a 25 gram per liter strip liquor.

Molybdenum Build-Up Detrimental

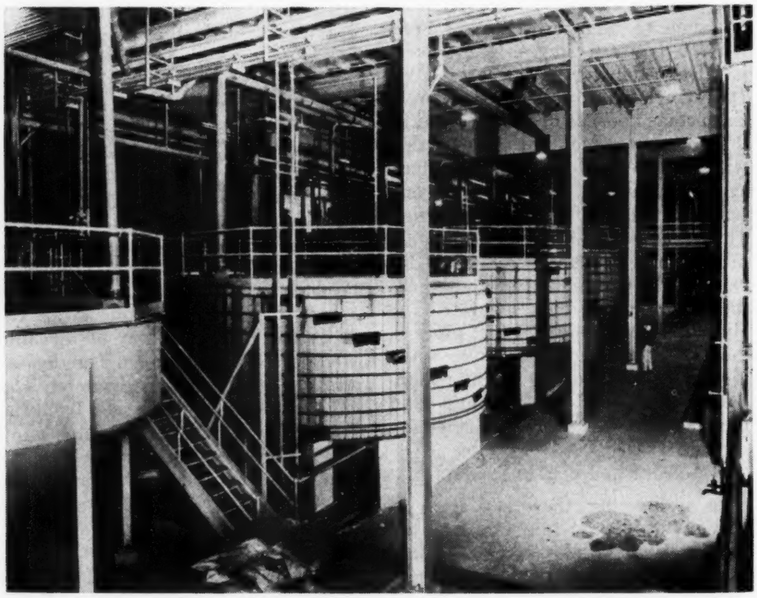
The only chemical problem has been molybdenum sludge formation in the stripping circuit. Molybdenum in the feed liquor is extracted by amine solvents, but it is not stripped out by a sodium chloride strip solution. If it is not removed, it continues to build up in the solvent until eventually it interferes with uranium extraction. By bleeding a portion of the solvent continuously through a single stage mixer settler and contacting it with a soda ash solution and ammonia, the molybdenum can be removed, thereby preventing the build-up.

In addition to its poisoning effect on the solvent, molybdenum forms a complex amine chloride compound which is insoluble in kerosene and precipitates in the stripping circuit as a dark green gummy mass which accumulates at the settler interface. This is not only detrimental to operation of the settler but also represents a loss of amine. Fortunately this precipitate is soluble in hot soda ash ammonia solution and the amine can be recovered for re-use.

In the pilot plant work, this green sludge formation was observed if the molybdenum concentration of the leach liquor rose up to 0.030 grams per liter. Apparently the formation was determined to some extent also by the chemical form of the molybdenum, since it was not particularly noticeable when leach liquors were spiked with added molybdate to quite high levels. Although alternate stripping methods were developed which avoided the green sludge formation, it was believed that the molybdenum content of the average ore feed would be below the value that would cause sludge formation.

It has been found in the Kermac mill that this sludge forms rather continuously when treating some ores and has necessitated periodic removal. These clean-out periods are about every three months.

The most serious part of the problem is the loss of amine, which is greater from this cause than from solvent loss by entrainment in the raffinate from the extraction circuit. Much of this amine is eventually recoverable.



Buildup of a molybdenum sludge in the stripping circuit is prevented by continuously bleeding a portion of the solvent and contacting it with a soda ash solution and ammonia for molybdenum removal

Solvent Losses in Raffinate Costly

A major cost item of solvent extraction is the loss of solvent by entrainment in the raffinate. This problem of solvent loss and how it could be determined in small scale work was studied intensively in the pilot plant over a period of a year. Many kinds of analytical methods were developed for determining the amount of entrained solvent, some of which were very useful for spot checks. The most conservative way to determine this loss on a small scale, however, is to exercise careful control to see that there are no spills, leaks or evaporation losses and then to use the inven-

tory method. This method in the pilot plant indicated that total losses would be from 0.3 to 0.5 gal of solvent for each 1000 gal of feed liquor treated. The average value at the Grants mill from the startup to September 1, 1959 was 0.21 gal of solvent per 1000 gal of feed liquor.

One of the questions to be decided in designing a mixer-settler solvent extraction plant is the area required for the settlers. This is the phase separation problem, since different mixtures of organic and aqueous liquids will separate at different rates, depending not only upon the liquid compositions and ratios but upon temperature and agitation intensity.

Design of Settlers and Mixers

In order to determine settler area requirements, the pilot plant extraction unit was operated under a variety of conditions, which might conceivably be encountered in practice, and the thickness of the separation zone measured. This separation zone is the layer of mixed solvent and aqueous in the settler which is undergoing the separation process. Above it lies clear organic, and below it is clear aqueous. Almost arbitrarily it was decided that if this dispersion band or separation zone was six in. deep, the unit was operating at capacity.

Under the worst conditions encountered on ores treated in the pilot plant, it was found that a settler area of 1.5 sq ft for each gallon per minute of feed liquor was adequate to achieve complete separation of the two phases. This was the design basis for the Kermac settlers. They were built to treat 800 gpm of clarified feed liquor at a temperature of 40°F representing what might be the case in winter with a high wash ratio. The operating performance at the mill has shown that this is a safe design for this solvent system. During the winter of 1958–59 each settler handled 800 gpm of liquor with a separation zone depth of about six to eight in., although this band is not so clearly marked in the large settlers as it was in pilot plant units. Last summer with higher temperatures, rates of 1200 gpm were obtained although such high rates would not be obtainable in colder weather or on some types of feed.

The Kermac mixers are designed so that organic recycle is obtained by the pumping action of the turbine blade which also mixes the organic and aqueous. A phase ratio of at least 1.5 parts of organic to one part of aqueous in the mixers is necessary, which requires a recycle volume of organic of 1200 gpm. The impellers in the 8 by 9 ft mixers have proven adequate, with ten hp motors, to achieve this recycle and at the same time provide enough agitation for the extraction. Brief studies of the dispersion in the mixers indicated that equilibrium was substantially reached.

One worry in the minds of people using solvent extraction is the possibility of emulsion formation. Happily there have been no emulsions in the extraction or stripping circuit except for the molybdenum sludge formation already described.

Instruments Used Only as Indicators

In the design of the plant units, considerable thought was given to the use of instruments for control. It was finally decided that instruments would be used in general as indicators but not as controllers. In addition, because even such a simple instrument as a flow recorder can be troublesome, weir boxes were placed in all lines where proper flow was essential to smooth operation. The solvent extraction operator controls the aqueous feed, the organic flow rate and the stripping brine flow rate. Then at hourly intervals samples are taken of aqueous flow coming from the second extractor. Based upon the assay of this sample, the operator adjusts the solvent flow rate to take care of minor fluctuations in feed assay. There are lights on a central panel board indicating whether the mixers and pumps are in operation, but other than this the circuit runs itself.

Control of the solvent depth, and therefore the position of the interface level, is set by the height of the standpipes through which the aqueous solutions flow and is not subject to adjustment by the operators. This is an important point in design because of a tendency to overadjust on the part of new or unskilled operators.

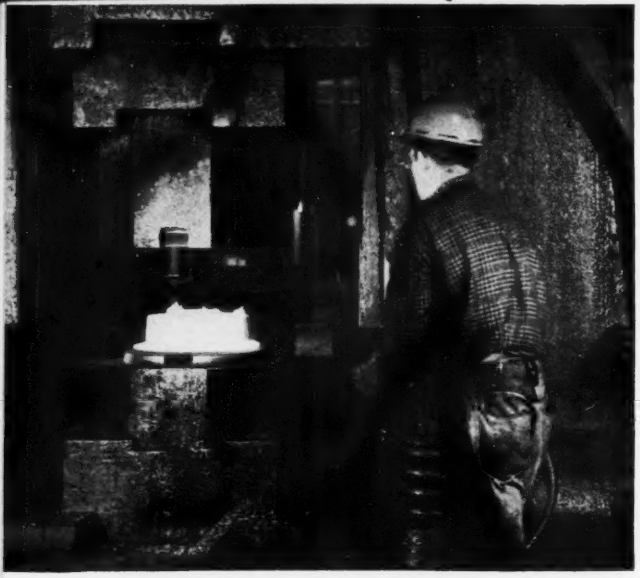
Since the organic pumps only advance that amount of solvent which flows to them in the overflow launders, no control of organic flow other than the barren solvent to the system is required.

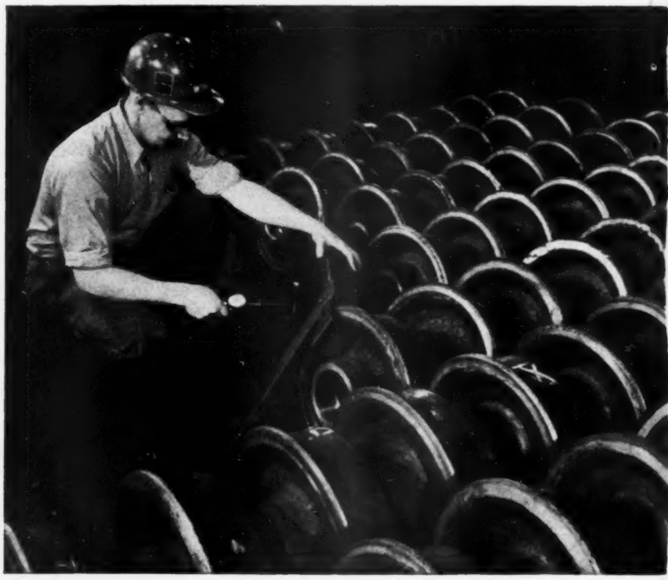
One Idea Borrowed from Petroleum Industry

Raffinate from the last extractor is pumped into a gravity type settler of the type developed by the American Petroleum Institute for removing oil droplets from refinery wastes. This installation has been very useful in solvent recovery. Although no estimate is available of how much this settling chamber recovers, every few weeks the layer of solvent which accumulates is pumped back to the extraction circuit.

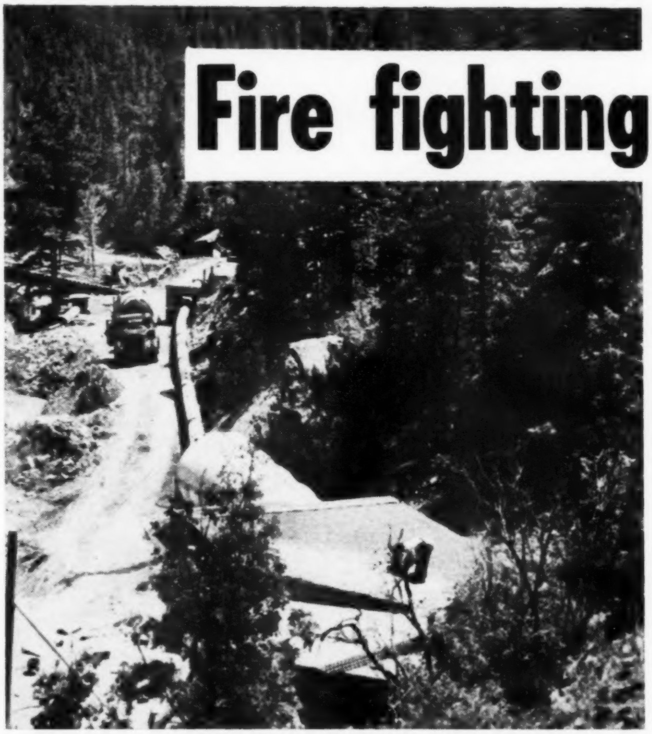
This report on the performance of the Ambrosia Lake uranium solvent extraction plant can best be summarized by stating that designed capacity was reached in the early weeks of operation. Anticipated recoveries were achieved and operating and maintenance costs have been within the expected range. This plant probably represents the largest scale application of solvent extraction in the mineral industry. Its record of smooth operation, during its first year in operation, is a demonstration of the practicability of solvent extraction as a useful mineral industry process.

Kermac's Ambrosia Lake plant probably represents the largest scale application of solvent extraction in the mineral industry





Fire fighting experiences



Both dry ice and liquid carbon dioxide were used to cool the fire area before recovery work was started. Pictured above, in Waldron Canyon, is the two-ft culvert used to convey fire gases back into the mine after they had been circulated through the dry ice chamber. Evase tube of the six-ft ventilation fan is in left foreground, and the dry ice chamber (not visible) is beyond the truck. See text for full details

Fourteen months, $750,000, and 3480 man-hours of work were expended in fighting the Koehler mine fire

By R. G. HEERS
Manager, Mining & Raw Materials
and
W. K. DENNISON, JR.
Mine Superintendent
Kaiser Steel Corp.

THE Koehler mine, located 23 miles southwest of Raton, N.M., was originally opened by St. Louis, Rocky Mountain & Pacific Co. in 1907. Closed down in 1923, it was reopened in 1942 and has operated at varying tonnages since that time. The seam varies from five to ten ft in thickness and dips 2° northwesterly.

R. G. Heers

W. K. Dennison, Jr.

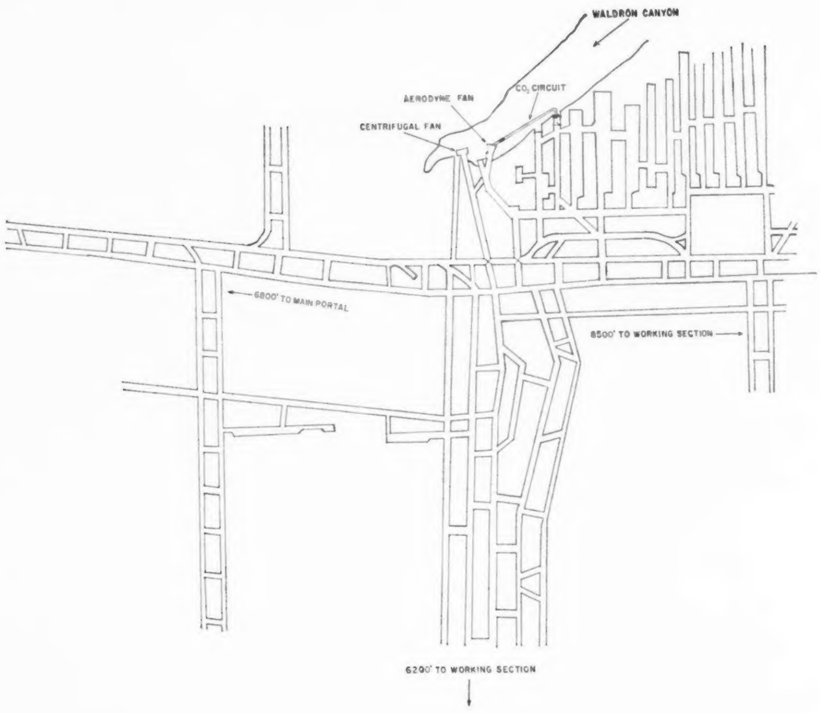
The mine, along with extensive coal reserves was acquired by Kaiser Steel Corp. in August 1955. A modernization program, which included enlargement of haulageways and installation of 90-lb welded track, was started in April 1957. Equipment in the production section presently consists of a Joy 6CM continuous miner, 10SC shuttle car, 11BU loader and an Acme rubber-tired twin-boom bolting machine. Twenty-seven ton trolley locomotives and 15-ton steel mine cars are utilized for coal haulage. Present production rate is 1500 tpd of clean coal. Maximum anticipated production, with present equipment, is 3000 tpd.

On Sunday morning, June 8, 1958, smoke was sighted in the Waldron Canyon area of the mine property. Immediate investigation revealed that smoke was pouring out of the two intake aircourses that surface in the canyon. The mine ventilating fan, which is located in the vicinity, was not running, and a quick inspection showed that the drive belts had suffered heat damage and that the fan was inoperable. Dense clouds of smoke were issuing from the Waldron entries.

Finding the Fire

A reconnaisance trip on foot from the Koehler portal in the main haulageway showed that the fire, burning on the bottom and ribs, was located just inby the intersection of the two main haulageways that served the entire mine. This intersection is 6900 ft south of the main portal and 400 ft northwest of the Waldron Canyon outcrop. It was also observed that the fire was active in the Waldron entries adjacent to where they joined the main haulageway. The mine roof in this area was supported by steel I-beams on wooden legs, along with some roof bolts between the beams. Some of the caves which occurred later along the haulageway were no doubt caused by the wooden legs failing as they were burned.

Upon returning to Waldron Canyon, the auxiliary fan was put into operation to clear the aircourses so they could be inspected and the extent of the fire on the east side determined. Approximately 100 ft from the surface, the heat was intense and the roof was beginning to cave. This automatically ruled out any further advance, but the fire could be seen approximately 150 ft further in. It was then decided to begin sealing operations, because roof conditions, heat, smoke, etc., precluded any at-



Map of Koehler mine fire area shows CO_2 circuit

tempts to fight the fire directly.

It might be well at this point to explain why it was felt that the fire was fairly well confined and had not spread further along the intake airways. The overcast at the intersection of the main haulage and the return from the west side of the mine had been removed and work was in progress to replace it with one permitting greater clearance. To prevent the air from being short-circuited, a temporary wood, brattice and plaster stopping had been erected between the overcast and the fan. This stopping was dislodged and consumed by the action of the roof and the fire. This permitted most of the air to be short-circuited, and instead of following its normal course along the intake airways to the working sections, it was returned directly to the fan. Had this not occurred, it is quite possible that the fire area would have been much more extensive.

Sealing Operations Leave 28,000,000 Cu Ft of Air in Mine

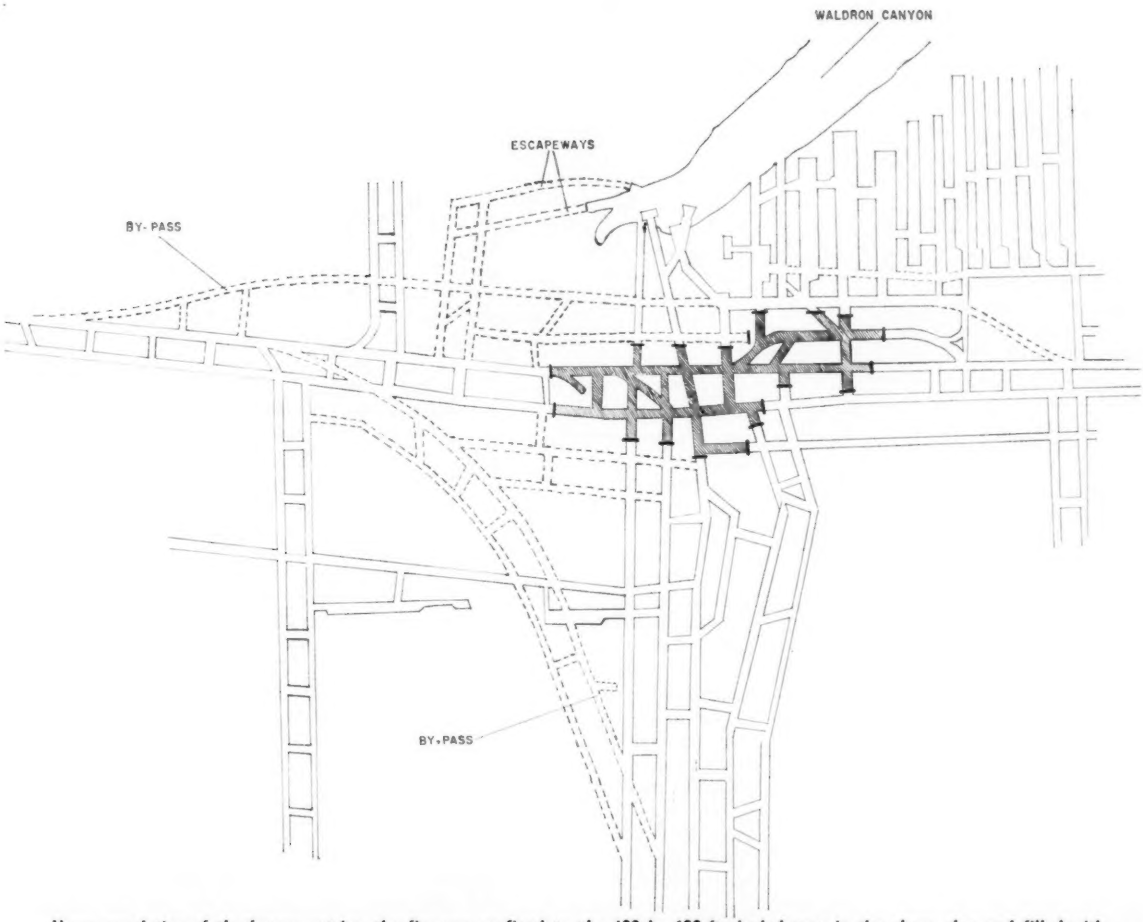
The locations that were selected to be sealed were on intake airways and the auxiliary fan was kept in operation to insure fresh air to the working crews. Work was started simultaneously on seals in the Waldron intakes and on the main haulageway. Seals in the main haulageway were started approximately 600 ft outby the fire area. The Waldron seals were completed, one seal in the main haulageway was finished and the second was 75 percent complete when the auxiliary fan, operating exhausting, began to pull flames to the surface. The man stationed at the fan for that purpose, disconnected the power to the fan. When the fan was turned off, smoke began to back up through the unfinished seal in the haulageway, and the work crews were forced to retreat to a location approximately 2300 ft outby the fire area and begin sealing operations anew. At this time, the doors to the fans were closed and all cracks and joints were plastered and caulked, cutting off the air supply to the fire from the Waldron area.

Seals in the haulageway were completed without incident and the main sources of air to the fire were blocked off by 11 p.m. However, there was no possible way to approach the fire area from the south and west sides to isolate it entirely, so there was approximately 28,000,000 cu ft of air in the mine that was available to the fire behind the seals.

Over 1300 Tons of Carbon Dioxide Used

The temperature at the Waldron seals was 128° F the day after sealing. It was obvious that the area would have to be cooled off before any exploratory work could be undertaken. An airlock, approximately 60 ft in length was constructed outby the fire seal in the south Waldron entry. A closed circuit between this airlock and the main ventilating fan was constructed of two-ft diam corrugated culvert. A two-ft blower was installed in the line to provide ventilating pressure. The fire seal inby the airlock, or ice chamber, was knocked out. Twenty-ton loads of dry ice, in 60-lb blocks, were placed in the chamber, following which the inby door of the chamber and the door where the two-ft tubing entered the evase tube of the fan were opened. As the blower was put into operation, the fire gases were exhausted from the sealed area, passed over the dry ice and reintroduced into the fire area.

The first load of dry ice was put in the chamber on June 10, 1958. With dry ice in the chamber, the temperature of the gases in the line dropped as low as 60° F. When there was no ice in the chamber, tempera-



Upon completion of the bypass entries, the fire was confined to the 400 by 600-ft shaded area in the above plan and filled with water to the original roof line. It is still sealed off

ture in the line ranged from 90° to 136° F.

Some liquid carbon dioxide was introduced to the area through a pipe in the fire seal in the north Waldron entry.

The carbon dioxide would have been more effective had there not been cracks to the surface from the underground area. These were sealed on the surface where located, but it was obvious that some of the cracks remained undetected since the oxygen content in the sealed area was never reduced below three percent. Over a period of seven months, a total of 1302.5 tons of liquid and solid carbon dioxide were introduced behind the seals. Upon vaporizing, this would produce 23,500,000 cu ft of carbon dioxide gas.

Initial Recovery of Fire-Damaged Areas

Exploration operations, using McCaa two-hr self-contained breathing apparatus with full facepiece, was started from the Waldron side on June 23. Progress was slow due to poor visibility from soot and smoke and to intense heat. Exploration, at this time, was limited by these same factors. It was impossible to maintain a sense of direction in the smoke and a life line was used in this work.

Advance was accomplished by construction of block and masonry seals in pairs to form airlocks. In the initial stages of this work, advances were limited to a distance of from 20 to 30 ft. The seals were advanced until it was certain that the main return airways to the fan would be accessible to rehabilitation on fresh air, and the Waldron area was allowed to stand for a time.

Temperatures up to 150° F were encountered as work advanced and the apparatus crews had to be relieved every 20 to 30 minutes under these conditions. Maximum temperature recorded during later underground exploration was 189° F. Highest temperatures were found at large caves. This appears to be due to the burning material under the fall and the heat retaining characteristics of the exposed sandstone.

While recovery work was taking place in the Waldron area, a fan was being installed at the Koehler main portal. The atmosphere in the haulageway had been contaminated with carbon monoxide, leaking through faulty seals and roof cracks. The fan was put into operation and apparatus crews, utilizing airlocks, advanced to the edge of a large cave at the north edge of the fire area. Permanent seals were constructed at the edge of the cave.

While the fire had been deprived of air from outside for some time, the south and west sides were still open to the general mine atmosphere.

The normal work efficiency of an individual is reduced to half or less when wearing apparatus and any additional unfavorable conditions further reduce his efficiency accordingly. Also, the psychological effect created

by donning the apparatus to enter a known hazardous area, certainly isn't one that contributes to increased efficiency.

Where conditions permitted, all work, such as mixing cement and sawing timbers, was performed by workers at the fresh air base.

Foam Plug Didn't Work

In the early stages of recovery work, the foam plug method of advance was tried. Sufficient foam, the height and width of the entry, was generated behind the net, but attempts to advance it by manual sweeping failed. Conditions were such that the foam could not be given a fair test, although it would seem to have a definite application for a fire in an open entry with no caves. Burning coal, under a cave, is insulated by the cave from the effects of the foam.

Fire Area Bypassed

Exploration trips had shown that an 800-ft section of the main haulageway was caved to a maximum height of approximately 35 ft. This section of haulageway had to be bypassed.

Work was started on bypass entries that would circumvent the fire area, which was caved, and provide access for installation of seals that would encompass the area. These entries would also replace the sections of the haulageways that were lost to the cave that resulted from the fire.

The biggest problem to be faced in the recovery operations was presented by the caves that were encountered. Areas of the mine that had burned but had not caved, were recovered with comparatively little trouble.

Bypasses had to be driven through a number of old aircourses and entries. In the majority of cases, large caves were encountered when these were intersected. As the intersections were loaded out, seals were immediately installed so that the ventilation in the bypass could be controlled. Cleaning up and timbering of the intersections was very slow due to heat and poor visibility. The caved area above the original roof line was filled with smoke and installation of roof support prior to loading the fallen material was a very difficult task.

In two instances, aircourses that were intersected began burning again as soon as the air hit them. In both cases it was necessary to drive the bypasses on through these areas. This meant supporting the roof, loading the burning material and erecting seals to isolate the bypass from the active fire region. Both of these caves extended approximately 16 to 18 ft above the original roof line and here again the smoke that remained in the caved portion made timbering operations extremely hazardous.

The burning material was sprayed with water as it was being picked up by the loader, as it was discharged into the shuttle car and finally when it was being loaded into the mine car. As each 15-ton car was loaded, it was immediately taken to the surface and switched on a side track away from any structures.

Steam that was generated during the loading operations caused some further caving, but none of any great magnitude. However, the steam did cause very poor visibility. It was necessary to move the loading machine back from the caved area several times and drench it with water to cool it off.

Once one of these intersections was opened up, it was mandatory that the work continue until it was cleaned up and seals were installed.

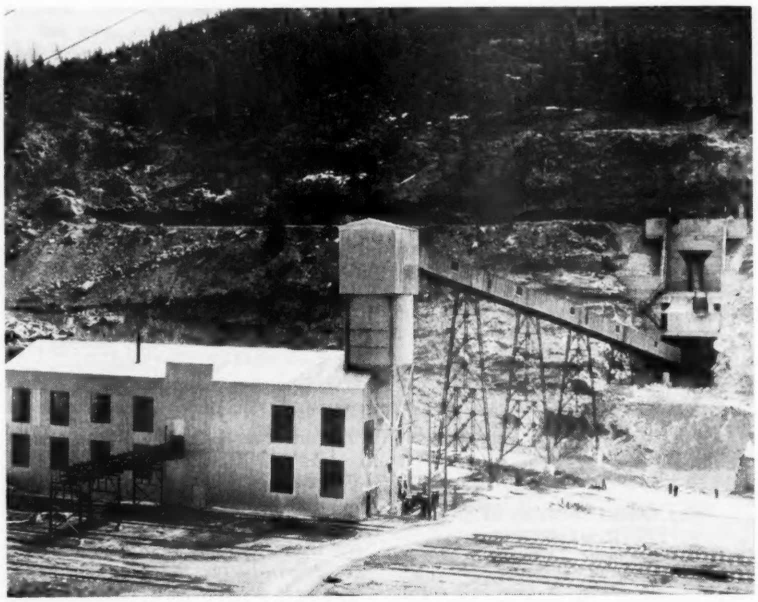
One of the outstanding lessons that was learned early in the recovery operations is that you cannot successfully fight a mine fire with the mine fan operating exhausting. Any leaks in seals, broken roof or fractured coal provide a potential hazardous condition from contaminated air when the fan is exhausting. Both methods of ventilation, exhausting and blowing, were tried. It was found that the entire area exposed to ventilation could be kept clear when operating the fan blowing. This did not hold true when operating exhausting.

Upon completion of the bypass entries on June 8, 1959, temporary seals were installed on the south and west sides of the fire. To reduce the sealed area to a minimum, all seals were advanced to the edge of the caved area and strengthened by the addition of reinforced concrete in preparation for flooding within the area. Flooding was started on June 29, 1959. The entire area was filled with water to the original roof line and is still sealed off.

Release From Withdrawal Order

On August 11, 1959, an inspection was made by a three man team from the U. S. Bureau of Mines, and all of the mine, except the area behind the seals, was released from the Withdrawal Order that had been posted in June 1958. It had taken 14 months, three quarters of a million dollars and 3480 actual man hours of work while wearing oxygen breathing equipment in a lethal atmosphere, to confine the fire into an area approximately 400 by 600 ft.

Within a short time after completion of training, apparatus crews were performing their work at top efficiency. Morale remained exceptionally high among these crews, and there was not one lost time accident during the entire recovery operations.



The fire was 6900 ft from the main Koehler portal

Viewpoints on Safety

Part IV—The Top Executive's Role

To achieve a good safety program a company must be willing to:

- ***Rank it with production and profits***
- ***Spend what is necessary to obtain maximum safety***
- ***Establish direct-line responsibility***

By C. D. MICHAELSON
General Manager
Western Mining Divisions
Kennecott Copper Corp.

MANAGING a company is very much like riding a bicycle. To maintain stability, you have to keep moving.

One of the fields in which Kennecott has kept moving is in the promotion of safety. The company has a program that it is very proud of—one that is paying off in practical, dollars-and-cents results each year. It is not the writer's intention to describe this program, but it will be drawn on to illustrate certain basic principles that should govern top management's role in safety.

It is almost impossible to discuss safety and say anything fresh or new. Safety is a universal ideal—like truth, honesty and motherhood. Just as everybody is for motherhood, everybody is against accidents.

The problem with industrial safety is not *whether* you should have it, but *how* you can best achieve and maintain it. Basic safety problems are the same whether an organization is engaged in producing donuts or manufacturing wing nuts, in making brake shoes or canning tomatoes. There is one common denominator to all production and service. That common denominator is people—the human element. It underlies efficiency—it is fundamental to safety.

You Get the Kind of Safety You Insist on Having

A good safety program requires three things. First, and most obvious, is top management belief in the importance of safety, and willingness to give it high priority; in fact, to rank it up alongside production and profits. One of the top officials of a large manufacturing company said recently: "I am asked now and then if my company actually rates safety on a level *with* production. My answer must be that it does not. It rates safety *ahead* of production." Without such an attitude at the very top, no safety program will ever amount to much. You get the kind of safety you insist on having, and only that kind.

The second requirement is that a company must be willing to spend whatever amount it takes to achieve maximum safety. This includes not only money for administration of a safety program and for safety education, but also capital outlays for safer machinery and equipment and safer plant facilities. The author has had businessmen say to him, "Yes, but that costs a lot of money." The answer is, "not nearly as much as accidents cost." Quite apart from the suffering, heartache and tragedy that

A division-wide safety meeting, where division and Western Division general managers presented safety messages to some 350 supervisors in attendance

accidents bring, the economic burden to a company can be very heavy. Accidents literally cost a fortune—to the victim and to the employer.

Line Personnel Must be Held Accountable

The third requirement for safety—and by far the most important—is this: The way to get a safety program to work is to establish *direct line responsibility* for safety, from the top executives down through division managers and plant superintendents to work center supervisors.

A line organization can be provided with the services of safety specialists, but line personnel must at all times be held strictly accountable for the safety record of every department and every individual employe. There must be absolutely no opportunity to pass the buck. Safety is no job for a committee.

It is amazing how quickly managers become interested in safety once they are held personally responsible. The story is told about the founder of the Du Pont Co. and his approach to the problem of safety. In France, where he learned the explosives business, it was the law that workers and management of all government explosives works must have their homes and bring up their families on the immediate premises of the actual arsenals. This was, as might well be suspected, a very practical safety device.

So when Mr. E. I. Du Pont founded his company in the United States in 1802, he built his own home just a few hundred yards from the powder mill. It is an interesting and significant fact that he lived out his years in that home—and that house is still standing today, in good repair.

Responsibility Cannot be Delegated

Once line responsibility is established, it goes without saying that promotion must be made contingent on a man's safety performance record. Salary increases should be withheld if the performance falls down. Any flagrant violation should bring dismissal.

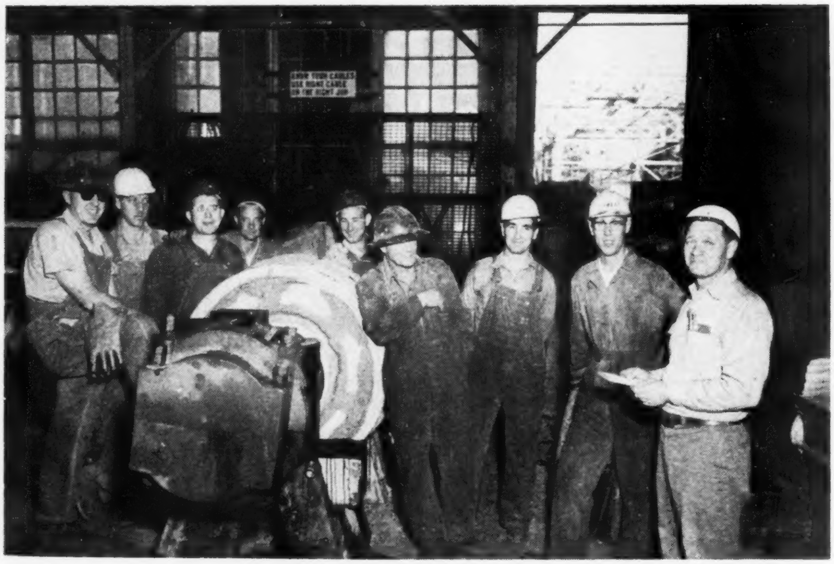
Conversely, an incentive program can also be effective. One large company bases a bonus system on safety performance. Bonuses may run up as high as 100 percent of salary, but if there is one death the plant manager gets no bonus that year.

Industry today puts great emphasis on decentralization and delegation of authority. That works fine—for everything but safety. Responsibility for safety is something that just cannot be delegated and forgotten. Every work center supervisor must be a safety expert. He must understand that nothing less than a perfect safety record is acceptable to top management, and that he is personally responsible for it.

Obligation Extends Beyond the Plant

A well-organized program should not confine itself only to on-the-job safety promotion. Training programs to make employes safety conscious are, of course, valuable and important, but the effort should not stop there.

Through television, radio, newspapers, company publications and letters, the importance of safety can



A five-minute safety discussion being conducted on the job by a front-line supervisor with his men

be emphasized and re-emphasized. Safety in industry, safety on the highways, safety in the home—all are areas with special themes. It is the author's feeling that business and industry have not only an opportunity but an obligation to extend their safety resources and experiences and know how beyond the factory gate out through the whole community as a public service.

Every new plant expansion or addition ought to be studied most carefully from the safety standpoint before any work commences. At Kennecott, project managers and division general managers correlate the opinions of medical doctors who set limits on environmental conditions under which a man can work safely. Plant designs are checked by specialists in ventilation, machine design, architecture, heating and lighting.

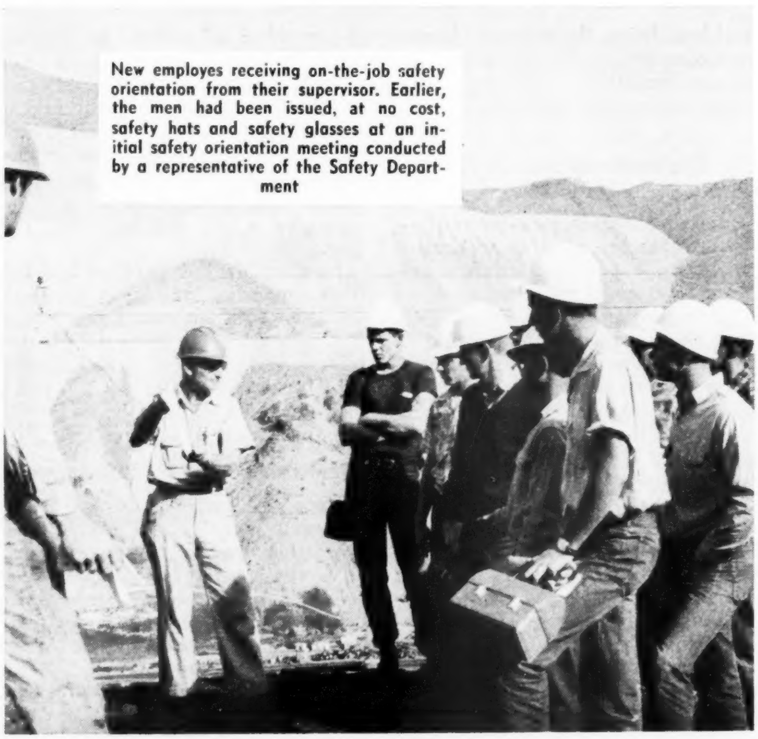
Special safety studies should be undertaken frequently. For example, accident statistics at one of the company's operating divisions were evaluated to determine accident proneness and some very interesting figures were developed. It was found that 7 percent of the employes sustained 25 percent of the accidents. This led to a re-evaluation of the employe placement program. Physical examinations, to make sure that employes are placed on jobs for which they are physically qualified, can cut down measurably on accident rates.

Supervisory Authority Needed

Employe suggestion systems can play a vital role in safety. At Kennecott about 35 percent of all suggestions have to do with safety, and some important changes have resulted directly from these ideas contributed by employes.

Thus far the importance of line responsibility for safety programs has been stressed. With it goes a very important correlary; if a man is given responsibility, he must also have *authority*.

When a man is held accountable for the safety of those under him, he must be given the power to implement programs and institute changes that will help him achieve the safety goals. He must know that every manager, superintendent or work center super-



New employes receiving on-the-job safety orientation from their supervisor. Earlier, the men had been issued, at no cost, safety hats and safety glasses at an initial safety orientation meeting conducted by a representative of the Safety Department

visor is expected to demand whatever new procedures and whatever capital funds may be needed to promote safety—and that if he fails to point out these needs, he is shirking his duty. He must have the right to request any technical help needed to overcome any serious hazard to safety. It does little good to remedy the cause of an accident *after* the accident occurs.

Safest Men Make the Best Supervisors

To the man who alibis that an accident in his department was caused by some safety defect in a machine or a process, it must be pointed out that it was his job to spot the defect in advance and get it corrected.

In conclusion, it need not be emphasized that effective safety programs pay off. Kennecott has found that its safest mines and plants are its most productive ones, and that its safest men make the best supervisors.

The company's Chilean operation, Braden Copper Co.—which the writer had the privilege of managing for a number of years—has won first-place award of the Inter-American Safety Council for 11 consecutive years.

At the Bingham Canyon, Utah, mine, which is the largest open-pit copper mine in the world, the accident rate is so low that one man working 40 hours a week would have one accident in 121 years. In fact the Utah Copper Division, of which the mine is a part, has an enviable safety record, for during 1958, it won 32 awards.

There is no question that safety records such as these are due to the basic policy of line responsibility for safety.

Accidents in 1958 Cost $12 Billion

The fundamental purpose of a safety program is, of course, to prevent the suffering and heartbreak and tragedy that accidents bring, but another important purpose is to cut the costs that they bring.

In 1958 alone, according to the National Safety Council, accidents in the United States cost almost $12 billion. This is three times as much money as this country is spending on foreign aid. The cost of work accidents alone was close to four billion dollars, and traffic accidents accounted for another two billion dollars! So for economic reasons alone, every business and industrial man ought to promote safety with everything he's got.

Good safety is good business. The smart businessman realizes this and acts accordingly.

ROOF SUPPORT

Roof Falls at Intersections*

INTERSECTIONS and their surrounding areas constitute up to 40 percent of a typical mine's total area. They are the avenues of communication between working places or entries, the means of establishing and continuing ventilation, and are the access roads of the haulageways.

A mine intersection can be likened to the crossroad of a highway in that it is frequently the scene of an accident. During 1958, 61 of the 176 roof fall deaths in bituminous coal mines occurred at intersections.

To prevent such accidents, safer procedures must be adopted. For instance, the turning point of an intersection at the face, particularly from an unsupported area, requires that workmen expose themselves beyond the support line. A better practice is to drive a straight face beyond the point of intersection, support the roof to the face, and *then* turn the intersection.

Double intersections turned at the working face require more than extra care, since the normal roof span is tripled, that is, extended to three times what has been determined to be the safe working span. The maximum allowable roof span is determined through experience or through a study of the nature and strength of the immediate roof. Once determined, the distance between roof bolts or other installed supports is specified. This dimension applies to the distance between the face and the last support as well as to the distance between supports.

Roof of an intersection away from the face is in itself a problem of support. It should be initially supported to maintain it secure through its life. In order to visualize the roof of an interestion away from the face, we must see it as a large slab of rock resting on four or more coal supports. This slab, as mining advances toward it and retreats from it, is subjected to multi-directional stresses which may cause shearing and breaking off of the rock along the abutment zones.

In mines where roof bolts are used as the only means of support or as supplemental support to the conventional timbering on the first mining (development work), the whole support plan should be re-examined and revised before second mining (pillaring) is started, because many changes will be necessary. Roof bolts should not be used as the only means of support in pillar mining, but may be used to supplement an adequate conventional timbering plan. Intersections adjacent to pillar mining should be given special consideration, which may include the use of cribs, as well as conventional timbers.

To reduce the uneven flexing of the strata is the first important step in support. This can be done by adopting a uniform system of mining in which the pillars of support are of equal size. Secondly, the width of places or length of spans should be curbed to a minimum as far as possible. Further, a support system which reduces the roof span more to conform with the strength of the material should be incorporated. Lastly, only a support system that cannot be displaced by moving equipment should be adopted.

* *Prepared by the Advisory Committee 1960 National Campaign to Prevent Injuries from Roof Falls in Coal Mines.*

By H. E. STEINMAN
Chief Mining Engineer
Vesta-Shannopin Coal Division
Jones & Laughlin Steel Corp.

An Operator's Approach to Mine Water Drainage Problems and Stream Pollution

- ***Keep water out if possible***
- ***Get rid of it fast once it enters mine***
- ***Reduce exposure to acid-forming material to a minimum***
- ***Regulate discharge***
- ***Sample regularly***

ACID mine waters and the problems they have presented to the coal mine operator as a source of stream pollution have been with the industry for years. Volumes have been written about the formation of acid mine water and its effect on stream pollution. State, Federal and local agencies have been trying to adopt practical laws that will prevent stream pollution and yet not strangle the coal mining industry.

The coal mines of Jones & Laughlin Steel Corp. are located along the Monongahela River in Washington and Greene counties of Pennsylvania.

Coal reserves in the Monongahela watershed are enormous. A recent survey of the Dunkard Creek watershed, a tributary of the Monongahela River, revealed an undeveloped reserve of 1.5 billion tons of coal in the Pittsburgh seam. To this tonnage in the Pittsburgh seam must be added the tonnage in the Sewickley and Waynesburg seams, which also is recoverable. That all of this coal will be mined is inevitable.

These reserves are only a small fraction of the total reserves in this Nation and many are located along uncontaminated streams. Considering this, one realizes the formidable problem involved. The coal industry and the regulatory agencies must come forth with practical laws and methods to assure the extraction of these reserves with a minimum of stream pollution.

Progress has been made, as indicated by the fact that a large measure of the industry today is complying with clean stream acts as set forth by the various regulatory agencies. The largest contributors of acid mine water discharged into the Monongahela River are the numerous abandoned drift mines along the watershed. So far as can be ascertained, no practical solution or abatement of the acid mine water flowing from these mines has been found. Mines which have been abandoned for as long as 40 years still are producing a large volume of acid drainage.

Recommendations to Minimize Mine Acid Formation

In 1946 the Sanitary Water Board of the Pennsylvania Department of Health initiated an intensive research program toward the cause and control of acid mine water. This program has been conducted by the Mellon Institute. Although it is far from completed, certain recommendations have been set forth for coal operators to follow to keep mine acid formation to a minimum. These recommendations are based on the basic precept that water, as it enters the mine from the overlying strata, is generally alkaline in nature.

If this water can be collected in the mine with a minimum of contact with the acid forming material present in the coal and adjacent strata, it usually will stay alkaline and can be disposed of in accordance with the existing clean stream laws.

Strict adherence by Jones & Laughlin to the recommended practices[1] advanced by the Sanitary Water Board and the Mellon Institute has been the basis for the success the company has experienced.

These practices are listed below:

1. Surface water and ground water are diverted where practical to prevent the entry of, or reduce the flow of, water into and through workings.

2. Water is not allowed to accumulate in working areas. Sumps are dug in low spots and kept pumped out, thereby keeping the water from the acid-forming pyrites on the face. Numerous pick-ups are employed for each pump.

3. Wherever possible, pipes, instead of ditches, are provided to conduct water by gravity. This keeps exposure to acid-forming material on the bottom to a minimum.

4. Gathering or main sumps are provided in the mine by driving separate sump entries or by digging up the bottom. See figure No. 1 for a layout of a typical sump entry driven into a barrier pillar along the main haulage. This practice does not permit water to accumulate in the local low gob areas with large acid-producing surface areas exposed to the water. These large sumps also provide reservoir capacity and prevent surges of mine water from entering a stream.

5. Discharges into streams are regulated, insofar as practical, to equalize daily accumulation throughout a 24-hour period.

6. Samples are taken periodically to determine the quality of the mine water discharged. These samples are gathered and processed at the company's analytical laboratory in accord-

[1] A series of articles published in *Mechanization*, January to June 1954.

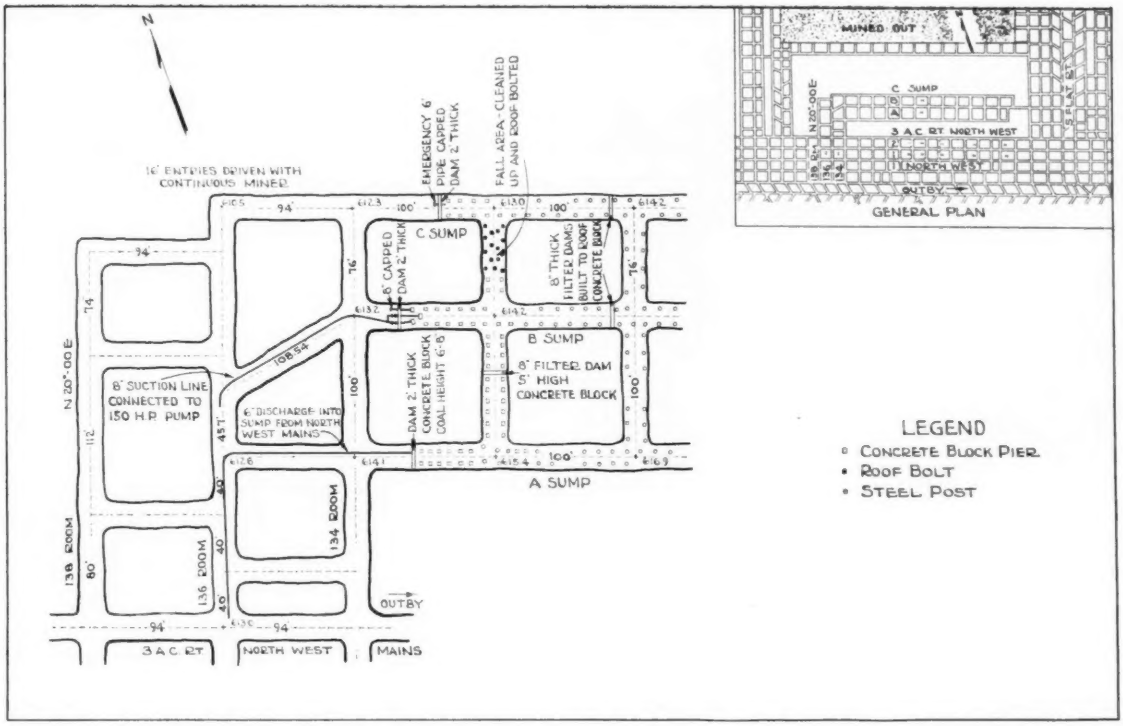


Fig. 1. Gathering or main sumps are provided in the mine by driving separate sump entries or by digging up the bottom. In this way water is not permitted to accumulate in the local low gob areas with large acid-producing surface areas exposed to the water. These large sumps also provide reservoir capacity

Fig. 2. Water discharge points at the Vesta mines in relation to clean and contaminated streams. Because the alkaline discharge is about twice that of the acid, the over-all result of the combined discharges into the Monongahela River tends to neutralize the acid present in the river and is therefore beneficial and not detrimental

Table I. Typical samples taken during a mine water survey

Sample No.	Location	pH	Acidity (ppm)	Total Iron (ppm)
1	49 Face Dam	7.6	− 435	1
2	46 Face	7.8	− 680	Trace
3	48 Face	7.9	− 980	Trace
4	36 Face	4.0	+ 105	18
5	32 Face Bleeder	7.9	− 990	Trace
6	15 Rt. Bore Hole Discharge	7.1	− 260	29
7	30 Face Bleeder	5.1	+2,100	1,121
8	No. 5-5 Bore Hole Discharge	7.1	− 235	Trace

Table II. Typical analysis of water discharging from the Vesta mines. Locations are indicated on figure No. 2

Water Discharge No.	pH	Acidity (ppm)	Total Iron (ppm)	Avg. flow per day (gal. per day)
5-1	7.0		Nil	490,000
5-2	7.8		Nil	30,000
5-3	6.5		Nil	660,000
5-4	3.0	+1,100	130	770,000
5-5	7.1	− 235	Nil	300,000
4-1	7.7	− 300	Nil	30,000
4-10	6.5		Nil	270,000
4-14A	6.7	− 274	59	4,000,000
4-16	7.8	− 451	25	388,800
4-18	7.1	− 300	22	300,000

ance with standards set forth by the Mellon Institute.[2] Records are kept to determine any significant change in quality.

Table I indicates the quality of mine water at various points in the Vesta No. 5 mine. It is apparent that some areas are highly acid. All of this water is combined in a sump, similar to that shown in figure No. 1, the discharge of which is pumped to the surface through borehole No. 5-5 into a clean stream.

If the result of the borehole sample indicates a change in the water quality, a complete water survey is made of the mine and appropriate action is taken to remedy the situation.

[2] *Mechanization*, August 1959; *Mining Engineering*, January 1957.

Drainage from Mined-Out Areas Is Continuing Problem

The above-mentioned practices apply to all new working areas. The company's mines have been in operation since 1900, and it, therefore, has many acres of old workings. Drainage from these mined-out areas is a continuing problem. The seepage from these areas may, or may not, be highly acid or have a high iron content.

If possible, the company combines this acid seepage with alkaline water from new working areas for neutralization before pumping it to the surface. If this is not practical, the acid mine water is pumped to an existing discharge point on a stream already contaminated. Figure No. 2 indicates existing water discharge points at the Vesta mines in relation to clean and contaminated streams. Table II indicates a typical analysis of the water quality from various discharge points.

On figure No. 2 the stream below borehole 4-16 is indicated as contaminated because of discoloration by iron. The water is of alkaline nature and serves to help neutralize the highly acid discharge of borehole 5-4. (See table II.) This does not, how-

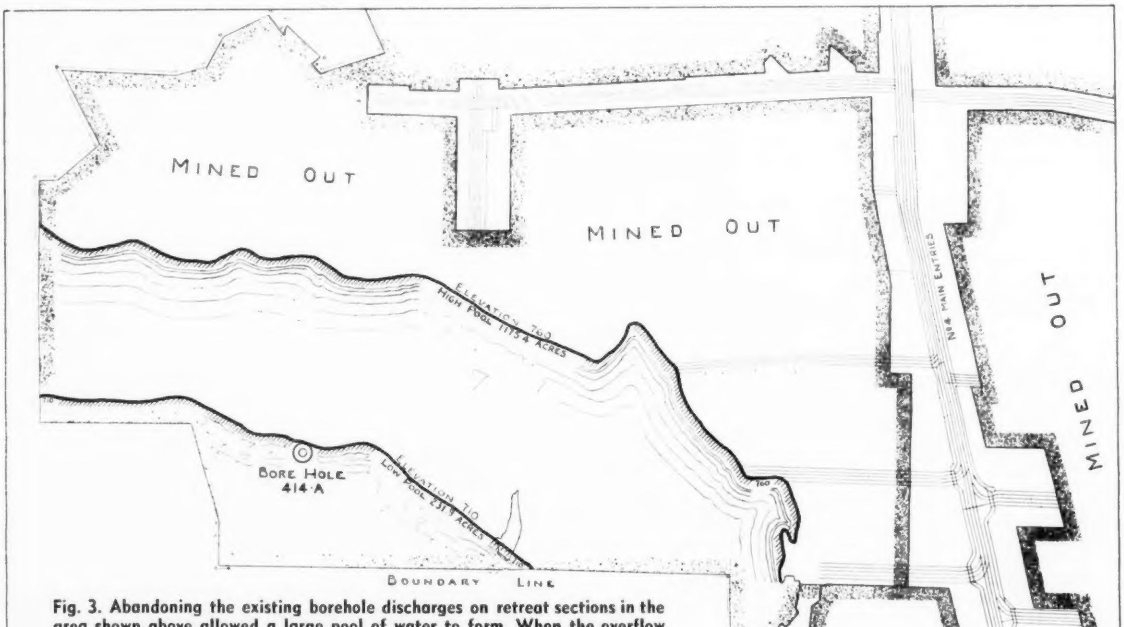


Fig. 3. Abandoning the existing borehole discharges on retreat sections in the area shown above allowed a large pool of water to form. When the overflow threatened to inundate the main haulage of Vesta No. 4 mine, two deep well pumps were installed at No. 4-14A borehole. The pumps were operated continuously and the water level was lowered to elevation 710. This diminished the area covered by the water considerably and improved the water quality remarkably. See text for full story

Table III. Analysis of bore hole discharge No. 4-14A from initial start-up to present

Date	Pool Level (ft)	pH	Acidity (ppm)	Total Iron (ppm)
June 1952	760	6.08	+ 61	179
June 1953	760	6.35	− 112	159
June 1955	766	6.00	0	215
Feb. 1957	739	5.60	− 205	197
June 1957	710	6.05	− 140	98
May 1958	712	6.70	− 260	95
June 1959	714	6.48	− 250	63
Dec. 1959	715	6.58	− 308	59

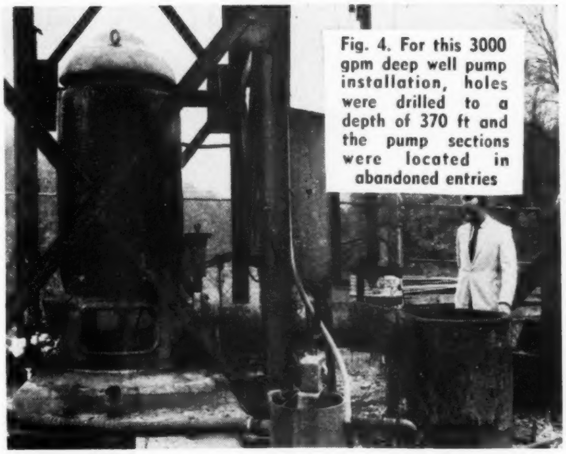


Fig. 4. For this 3000 gpm deep well pump installation, holes were drilled to a depth of 370 ft and the pump sections were located in abandoned entries

ever, make Ten Mile Creek a satisfactory stream.

Of all the discharges shown in figure No. 2 and table II, only borehole No. 5-4 is acid. Borehole No. 5-4 represents a discharge of 6776 lb of acid per day. The alkaline discharge on which minus acidity is given represents an alkaline discharge of 10,500 lb per day. Since the alkaline discharge is about twice that of the acid, the over-all result of the combined discharges into the Monongahela River tends to neutralize the acid present in the river and is therefore beneficial and not detrimental.

Iron Content of Water Varied With Pool Size

In one section of the company's mine the coal dips toward the property line barrier. Abandonment of the existing borehole discharges on retreat sections in this area allowed a large pool of water to form (figure No. 3). When the overflow threatened to inundate the main haulage of Vesta No. 4 mine, two deep well pumps (figure No. 4) were installed at the No. 4-14A borehole. The holes were drilled to a depth of 370 ft and the pump suctions were located in abandoned entries. The discharge, at a rate of 3000 gpm, enters a clean stream. The water is of an alkaline nature but contains iron in a ferrous state which, upon contact with the air, oxidizes to a ferric state quite rapidly.

At the outset of the operation of these pumps, the level of water was at elevation 760 and the area covered was quite large, as indicated on figure No. 3. The iron content of the water was prohibitive and discolored the stream objectionably from the discharge point to the Monongahela River, a distance of ten miles.

Diverting this water to other portions of the mine presented a formidable problem. Several methods of pumping were tried, varying the time and interval of pumping periods. No satisfactory method was found. Finally, at the suggestion of the Sanitary Water Board and Dr. S. A. Braley of Mellon Institute, the pumps were operated continuously and the water level was lowered to elevation 710. This diminished the area covered by the water considerably, as shown in figure No. 3, and improved the water quality remarkably.

Since this area is abandoned and has no circulating air current, the exposed gob area apparently does not oxidize rapidly. Also, the water seeping into the pool contacts less wall area and does not pick up iron. Table III is indicative of the improvement in the iron content of the water as the pool level receded. Today, the stream is discolored for a short distance below the discharge point. From this point on, the stream is clear and contains an abundance of aquatic life.

Slime Disposal Ponds Constructed for Preparation Plant

At the company's coal preparation plant, in order to comply with the clean stream laws, large slime disposal ponds have been constructed. Solids pumped into these ponds are in the minus 30 micron range and require considerable surface area to settle out. Adjustable overflow pipes (figure No. 5) are maintained at a level to assure a water white effluent.

While at the present time there is no known method of preventing acid formation, there are a number of procedures which can be used for control of acid water.

It has been the experience of Jones & Laughlin that, by following these certain practices, it has been able to comply with the clean stream laws. By doing so, the company has also realized an economic gain by not having pumps and piping destroyed by corrosion.

No one method can be set as standard, as each mine will have its own peculiar characteristics. However, after a complete survey of local conditions and water composition, some modification of these practices can be made to suit conditions encountered in the majority of mines.

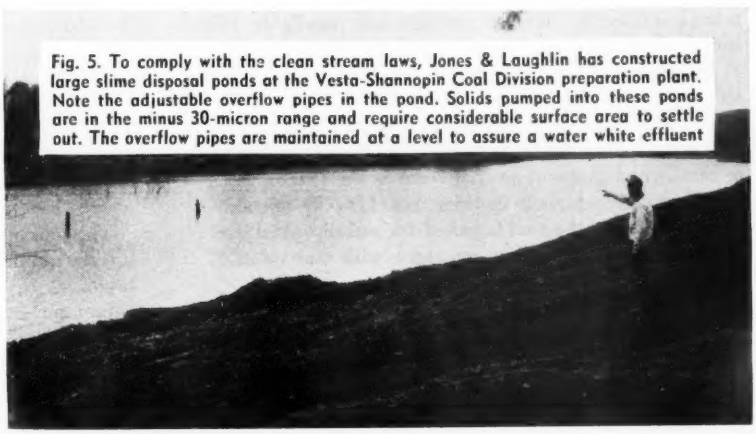


Fig. 5. To comply with the clean stream laws, Jones & Laughlin has constructed large slime disposal ponds at the Vesta-Shannopin Coal Division preparation plant. Note the adjustable overflow pipes in the pond. Solids pumped into these ponds are in the minus 30-micron range and require considerable surface area to settle out. The overflow pipes are maintained at a level to assure a water white effluent

Old Ben Dedicates New Mine

"It is highly possible that the opening of Mine No. 21 signals the beginning of a new era for the Midwest area as a steel center." . . . D. W. Buchanan, Jr., president of Old Ben Coal Corp.

ILLINOIS' newest major deep-shaft coal mine, Old Ben Coal Corporation's Mine No. 21, was officially dedicated June 14. The event is of great significance to the coal-steel economy of the Midwest, because the mine contains the largest commercially available reserves of metallurgical coal in the State.

Tapping a reserve of 100,000,000 tons of recoverable coal 670 ft below the surface, No. 21 is expected to be producing 3,000,000 tons per year by 1962. This will make it one of the largest bituminous coal mines in the United States. The coal seam is the Illinois No. 6 and averages nine ft in thickness. Low in ash and sulphur content, the coal is suited for metallurgical use when blended for coking purposes with low-volatile coals.

Maximum Capacity is 15,000 TPD

Designed for continuous mining and processing of coal, Mine No. 21 makes maximum use of automated equipment. From the time the coal is mined until it is loaded into waiting rail cars and trucks, it is handled almost completely automatically.

Boring-type continuous mining machines, powered by 440 volt a-c, are used to mine the coal. Eight units will be operating when the mine is in full production. Three shuttle cars and a twin drill roof bolter serve each miner.

The shuttle cars dump their loads on cable-suspended conveyors which are hung from the roof. Panel belts leading from the continuous mining sections are 36 in. wide. The "mother" belt is 42 in. wide.

The automatic loading and hoist control equipment for the mine is an integrated system. As coal is received at the 100-ton surge bin at the shaft bottom, automatic control equipment initiates transport of the coal from the lower bin to the surface coal bin. As long as coal is available, the system will continue to deliver. The skips reach a maximum speed of 1600 fpm during their ascent of 801 ft 9 in. from the bot-

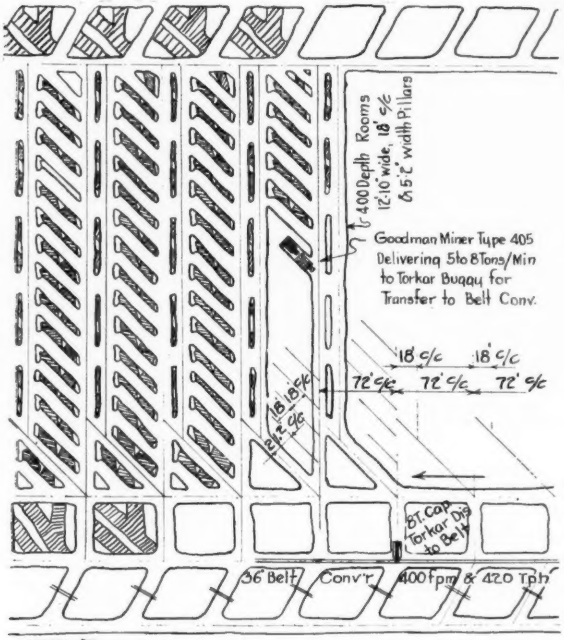
tom of the hoist shaft to the discharge point at the tipple above ground.

At present the mine is ventilated by a 144,000 cfm fan operating exhaust. A second fan will be installed when needed, to operate in parallel with the present fan. Each section of the mine in which a mining machine is operating will have a separate split of fresh air with a minimum delivery of 25,000 cfm.

The 756-ft hoist shaft is elliptical in shape, measuring 20 by 11 ft across, and is lined with concrete averaging 16 in. thick. Skips are hoisted by a 2200-hp motor located in the hoist house.

The 670-ft man and material shaft is also elliptical

Forty-ton continuous mining machines bore an opening 7 ft high by 13 ft wide. Eight of these units will be operating when the mine is in full production



By the time the mine is completely developed, approximately 6000 miles of tunnel will have been cut through the coal seam

in shape but measures 30 by 20 ft across. A 15-in. concrete partition wall divides the shaft into an air compartment and cage compartment. The man and material cage measures 9½ by 12 ft, large enough to hold 50 men at one time. The cage will also accommodate all but the largest pieces of mine equipment without dismantling; bulky equipment is suspended on the underside of the cage.

An underground shop near the man and material shaft will be used for minor repairs and overhauls. Larger equipment will be removed to the central machine shop above ground for major overhaul.

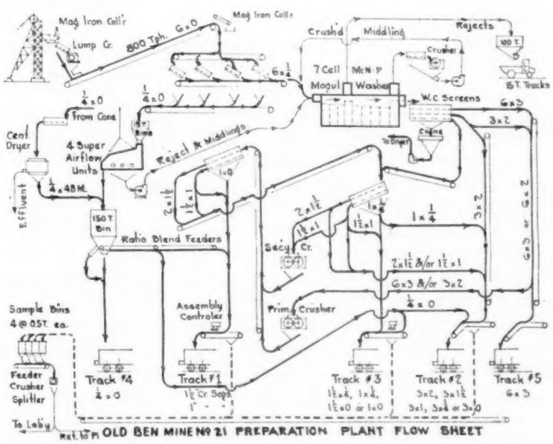
Preparation Plant Has 118 Major Units of Equipment

Coal is dumped directly into the tipple from the skips. In the tipple, the coal is crushed to a maximum size of six in., then transported to the main plant by a conveyor belt.

The main preparation plant has a capacity of 800 tph raw coal input plus 80 tph available for recirculation of middlings. Plus ¼ in. material is washed in a Baum-type jig, screened, crushed and transported to the loading conveyors. The minus ¼ in. is air cleaned.

In the preparation plant yard, rail cars are moved by a company-owned 35-ton diesel-electric locomotive. A scale weighs the car after loading, then electrically relays a signal to the mine office 600 ft away, where a recorder stamps the weight on a tape. A television camera at the scale lets the weighman in the mine office read the rail car number, which is recorded alongside the stamped weight.

Water for the preparation plant is obtained from a 170,000,000-gal reservoir created by damming nearby Jackie Creek. Washery effluent flows into a settling pond to prevent pollution of streams.



Involved in the construction of the preparation plant were 604 tons of structural steel, 53,000 sq ft of aluminum roofing and siding, 553 cu yd of concrete, 305 aluminum sash, 2300 panes of glass, 6½ miles of electric conduit and 40 miles of electric wire

As Viewed by HENRY I. DWORSHAK of the American Mining Congress

★ ★ ★ ★ ★ ★

Washington Highlights

CONGRESS: Recesses until August

TAXES: Congress, Court act on depletion issue

COAL: Research bill signed by President

IRON ORE: Escape-clause investigation ordered

LEAD-ZINC: House passes subsidy measure

IMPORT TAXES: Lead-Zinc schedule wins committee approval

SOCIAL SECURITY: Expansion bill now in Senate committee

MINIMUM WAGE: Hike to \$1.15 gets House okeh

UNION POWER: Bill would upset Supreme Court decision

EXPLORATION: Baker bill sent to President

★ ★ ★ ★ ★ ★

INSTEAD of working until the eve of the Democratic national convention, which began its deliberations July 11, and then adjourning for the year, Congress voted to recess July 3 and return to Washington in August to conclude action on remaining "must" legislation.

The Senate will reconvene August 8—one week after the close of the Republican national convention—and the House on August 15. Primarily because its rules do not limit debate, the Senate usually lags behind the House in enacting legislation and thus needs additional time. Final adjournment is expected to precede Labor Day.

CONGRESS, SUPREME COURT ACT ON DEPLETION ISSUE

In ten hectic days last month, Congress and the Supreme Court combined to settle some of the questions that have caused extensive litigation as to the proper "cut-off point" for determining the "gross income from mining" upon which percentage depletion is based.

Without prior notice, on June 18 Senator Albert Gore (Dem., Tenn.) offered on the floor of the Senate, as an amendment to the Administration-backed corporate and excise tax rate extension bill, the definition of "mining" which the Treasury Department proposed early in 1959. After extended discussion, the Gore amendment was adopted by a Senate vote of 87–0. The Senate also tacked on to the same bill two other revenue-raising measures—cracking down on entertainment expenses and repealing the dividends-received credit for individuals.

In a hurriedly called meeting, the American Mining Congress Tax Committee agreed upon a proposed substitute for the Gore amendment which would cure the major defects inherent in the Treasury's proposal. The House and Senate conferees did not accept the AMC substitute *in toto*, but they did substantially rewrite the Gore amendment, eliminating much of the harmful language and incorporating many of the provisions advocated by the Mining Congress.

The conferees finished their work on June 24, dropping the Senate amendments dealing with the dividends-received credit and entertainment expenses. The conference report was adopted by the House June 27, by the Senate June 28, and signed into law by the President June 30.

The new law defining "mining," which is effective for taxable years beginning after 1960, eliminates the "commercially marketable" test for determining what processes are allowable—thereby knocking out the end-product philosophy that found approval in the lower-court decisions of recent years. However, for the most part it continues to allow those processes which have traditionally been regarded as mining by the Treasury Department.

Some doubts have been cleared up in favor of the taxpayer—for example, uranium is clearly entitled to concentrating; sulphur is specifically allowed cleaning; and minerals customarily sold in the form of the crude mineral product are allowed processes which are "substantially equivalent" to sorting, concentrating and sintering to bring to shipping grade and form. In the case of calcium carbonates and other minerals when used in making cement, the new law allows "all processes (other than preheating of the kiln feed) applied prior to the introduction of the kiln feed into the kiln, but not including any subsequent process." Brick and tile clay producers will be allowed "crushing, grinding and separating the mineral from waste, but not including any subsequent process."

On June 27—the same day the House was adopting the conference report—the Supreme Court handed down its decision in *U.S.* v. *Cannelton Sewer Pipe Co.*, upholding the Government's view of the statute for past years. The Court held that a fire-clay producer must base his depletion on the value of the raw clay, in a decision which may have application with respect to many other minerals. While the Supreme Court's decision leaves some questions as to past years still to be answered, it is now clear that the adoption of the rewritten Gore amendment was actually a blessing in

disguise, because it might have been much more difficult to get reasonable treatment for the future if the Court decision had preceded the legislation.

At any rate, these developments settle many of the major questions which have kept percentage depletion for mining in the public eye in recent years, and which have caused so much uncertainty in the mining industry.

COAL RESEARCH MEASURE FINALLY BECOMES LAW

Congress has finally approved and the President has signed into law a bill authorizing establishment of an Office of Coal Research empowered, under the supervision of the Secretary of the Interior, to contract with State, local, and private organizations for coal research and development to supplement activities of the U. S. Bureau of Mines.

Strongly supported by the American Mining Congress and other coal industry spokesmen, the new law provides for the appointment of industry advisory committees to recommend research projects to the Secretary. An appropriation of $2 million is authorized for the first year's operation, with no ceiling on funds for coal research in subsequent years.

Interior Secretary Fred Seaton is expected to undertake immediate implementation of this legislation.

ESCAPE-CLAUSE INVESTIGATION OF IRON ORE ORDERED

At the request of Senator McCarthy (Dem., Minn.), the Senate Finance Committee has ordered the Tariff Commission to conduct an escape-clause investigation to determine whether imports of iron ore are threatening or causing injury to the domestic iron ore industry.

Under the Trade Agreements Act, which empowers the Commission to make such investigations, the agency is given six months to complete its study and submit its findings and recommendations to the President. If it finds injury, it must recommend to the President needed corrective measures, which the law provides may include "the establishment of import quotas, to the extent and for the time necessary to prevent or remedy such injury."

The Commission's investigation will include a public hearing later this year, at which all interested parties may testify.

HOUSE PASSED LEAD-ZINC SUBSIDY MEASURE

Legislation to provide subsidy payments to small domestic producers of lead and zinc was approved by the House late in June by a vote of 197–192 and, following approval June 28 by the Senate Interior Committee, was placed on the Senate calendar. Supporters expressed confidence that the Senate would also pass it and send it on to the President, but floor action was put off until next month.

The measure was opposed by the Interior Department, and it is not known whether the President would sign it.

During the debate in the House, proponents of the bill made it clear that it would not correct the major problems of the domestic lead-zinc industry. They said, however, that in the absence of adequate tariff or import tax protection, subsidy legislation is necessary to prevent the loss of present and future production of small mines now shut down or being maintained on a stand-by basis.

Subsidy payments would give producers the equivalent to what they would have received at lead and zinc prices of 17 cents and 14½ cents per pound, respectively. Payments would be limited to domestic producers whose production does not exceed 2,000 tons of lead and/or 2,000 tons of zinc per operating unit per year. A producer could not claim benefits for more than one mine in any State or mining district, but he could qualify twice if he is operating a small mining unit in each of two States or districts. Payments would be further limited to mines which were in production during all or part of the seven years preceding the effective date of the bill, which would expire June 30, 1965.

LEAD-ZINC IMPORT TAXES WIN COMMITTEE APPROVAL

An amendment which would impose import taxes on lead and zinc, with a portion of the new taxes removable whenever prices of the metals are at or above specified levels, was added by the Senate Finance Committee last month to a House-passed bill dealing with the tax status of American citizens residing in the Virgin Islands and Puerto Rico. Proposed by Senator Kerr (Dem., Okla.), the amendment is subject to Senate approval.

Shortly afterward the House Ways and Means Committee approved an identical bill sponsored by Rep. Baker (Rep., Tenn.) which, if it follows the normal route of such legislation, must be cleared by the House Rules Committee before it can reach the House floor for a vote.

If the Kerr amendment is adopted by the Senate as part of the Virgin Islands tax bill, it will be subject to the concurrence of House conferees, all of whom will be members of the Ways and Means Committee.

The Kerr-Baker legislation would put a fixed import tax on lead of 2 cents per pound, plus a removable additional tax of 1 cent per pound. The additional tax would go on when the price of lead falls below 13½ cents per pound and be taken off when the price reaches 14½ cents—based on quarterly averages. Similarly in the case of zinc, the fixed tax would be 1½ cents per pound plus a removable tax of 1 cent per pound, which would be applied when the price of zinc is below 12½ cents and be removed when the price reaches 13½ cents.

As to ores and concentrates import taxes would be as follows: Lead content, 1.4 cents per pound with a removable additional tax of 0.7 cents per pound; zinc content, 1.05 cents per pound with a removable additional tax of 0.7 cents per pound. Commensurate import taxes would be placed on lead and zinc manufactured items in addition to current tariff duties.

Present duties on lead and zinc metal, ores, and concentrates would cease to be applicable if this legislation becomes law.

HOUSE PASSES BILL TO EXPAND SOCIAL SECURITY

Late last month the House passed a bill which would (1) set up a $325 million-per-year Federal-State matching program to assist needy aged in meeting medical costs; (2) liberalize Social Security Act benefits by eliminating the age-50 eligibility requirement for disability payments, providing somewhat higher payments to surviving children of workers covered by the system, and expanding maternal and child welfare services; and (3) raise the Federal unemployment tax from 0.3 percent to 0.4 percent on the first $3,000 of covered wages—the increased collections to be used to make more funds available for loans to States which have exhausted their benefit payment reserves.

At least five separate plans have been proposed in the Senate to expand the medical care program by making it a permanent feature of the Social Security Act, financed by increased Social Security taxes, even though the Administration is opposed to this approach. The Senate Finance Committe has the House-passed bill under consideration. If it recommends Senate enactment of the House meas-

ure with little modification, a strenuous floor battle is in prospect.

MINIMUM WAGE INCREASE APPROVED BY HOUSE

The House has approved and sent to the Senate a bill to raise the present minimum wage of $1 per hour for persons covered by the Fair Labor Standards Act to $1.15 effective January 1, 1961, and to extend the Act's coverage to some 1.5 million workers heretofore exempt.

In approving the measure, the House rejected a more liberal version which would have increased the minimum wage to $1.25 per hour over a three-year period and extended coverage to approximately 5 million additional workers. Key vote to accept the more moderate substitute—which is less likely to encounter a presidential veto—was 211 to 203.

Almost simultaneously, the Senate Labor Committee approved a minimum-wage bill identical to that rejected by the House. A major battle is predicted when the measure comes up in the Senate.

DIRKSEN BILL WOULD UPSET COURT LABOR DECISION

Senator Dirksen (Rep., Ill.) has introduced legislation to remove "the creation or discontinuance of positions" from the area of compulsory bargaining with respect to labor-management contracts.

The occasion for its introduction, the Illinois Senator said, was a Supreme Court decision handed down recently in *Railroad Telegraphers* v. *Chicago and North Western Railway Co.* In that case, the Court held that a union could lawfully strike to prevent the railroad from discontinuing certain establishments and positions which were no longer necessary or profitable and the cost of which was impairing the company's financial position.

Dirksen's bill, which would apply to industry generally, would remove the creation or discontinuance of positions from the area of compulsory collective bargaining under the National Labor Relations Act and the Railway Labor Act, and from the area of lawful labor disputes protected against Federal court injunctions by the Norris-LaGuardia Act. A Senate Judiciary Subcommittee has been holding hearings on the measure.

PRESIDENT GETS BILL ON EXPLORATION EXPENDITURES

The Baker bill, H.R. 4251, to liberalize the deduction of exploration expenditures, was finally passed by the Senate June 23 and sent to the President. As enacted, the bill permits the deduction of exploration expenditures up to $100,000 a year, with a total over-all limitation of $400,000 per taxpayer, no matter how many years are involved. Prior law limited the deduction to four years per taxpayer, so approval of this bill would be helpful to those who spend money in exploration for minerals but whose yearly expenditures for this purpose are less than $100,000.

personals

C. Jay Parkinson, vice president and general counsel of the Anaconda Co., has been elected executive vice president and general counsel. Parkinson, a director of the Anaconda company and many of its subsidiaries, has been employed as a counsel to the company, and its subsidiaries and affiliates, since 1941. In 1955 he was elected vice president of Anaconda Aluminum Co., a wholly-owned subsidiary. In 1957, he was named general counsel for the Anaconda Co., and a year later was elected vice president and general counsel.

Roy A. Hardy, vice president and general manager and consulting engineer of Getchell Mine, Inc., has been elected to the company's board of directors.

Charles R. Nailler has been appointed vice president — operations of Consolidation Coal Co. For the past seven years he has been president of Christopher Coal Co., one of Consol's operating subsidiaries. Nailler went to work for Hanna Coal Co. in 1933. At the time Hanna Coal was acquired by Consol, he was general manager of mines, and in 1946 he was transferred to Christopher as vice president.

Harold Suter, vice president of Christopher, succeeds Nailler as president of that organization. Suter was superintendent of Pursglove Coal Mining Co. when Consol acquired that company in the early 1940's. He later became general superintendent of Christopher and its vice president in 1956.

Other organizational changes within Consol include the naming of **George L. Judy** as vice president-operations of Christopher, and **D. H. Davis** as vice president-operations of Mountaineer Coal Company Division. Judy was formerly vice president of Mountaineer and Davis was assistant to the vice president-operations of Consol. **William O. Barnard,** previously general superintendent of Christopher, has become general superintendent of Mountaineer Mine 32 and Mine 63.

Albert M. Garbade, a director and former vice president, has been elected president of United States Manganese Corp., succeeding **Frank B. Jewett, Jr.,** who resigned because of the pressure of other duties. Jewett, who is president of Vitro Corp. of America, will continue as director and member of the executive committee. U. S. Manganese is owned 40 percent each by Vitro Corp. of America and Sheer-Korman Associates and 20 percent by Great Divide Mining & Milling Corp., of which Garbade is president. The company is continuing a long-range, self-financed pilot program for the extraction of manganese from Colorado rhodonite using the Hierarc (high intensity arc) process.

Thomas J. Willing has been appointed general sales manager of the Berwind-White Coal Mining Co. and **Charles S. Smith,** district sales manager, Philadelphia. Willing, who joined the sales department of Berwind-White in 1941, was appointed district sales manager, Philadelphia, in 1947. Smith has been with the company for more than 30 years, and has served as secretary of several of its subsidiary companies. He has been associated with sales since 1942.

Milton E. Goul has joined New York Trap Rock Corp. as vice president of research and marketing.

Ernest N. Patty, who for the past seven years has been president of the University of Alaska, retired July 15. He is also president of Alluvial Golds, Inc. and Gold Placers, Inc., two gold dredging enterprises which have been in operation since 1935. Patty, who will reside in Seattle, will do consulting work on a limited basis.

Stephen F. Dunn, president, National Coal Association, has also become president of Bituminous Coal Research, Inc., an NCA affiliate. He succeeds **A. A. Potter** who is retiring. At the same time, it was announced that BCR had elected five new members to its 15-man board of directors. The new members are **B. R. Gebhart,** vice president, Freeman Coal Mining Corp.; **Harry LaViers,** president, South East Coal Co.; **E. B. Leisenring, Jr.,** president, Stonega Coke & Coal Co.; **H. C. Livingston,** president, Truax-Traer Coal Co.; and **S. F. Sherwood,** president, Stonefort Coal Mining Co., Inc.

S. F. Dunn

Robert F. Anderson has been appointed manager of domestic sales for the M. A. Hanna Co. In his new post he will have charge of all iron ore and nickel sales activity in the United States and Canada. Anderson entered the mining industry in 1947 as an engineer with Butler Bros. Co., which was later acquired by Hanna. In 1952 he was transferred to Hanna's Ore Sales Department and in 1958 was named assistant sales manager.

Seymour S. Jackson has been appointed to the newly created position of vice president-administration, Kennecott Copper Corp. Jackson has been associated with Kennecott and its subsidiaries since 1926. From 1954 until his recent appointment he had been the company's counsel.

Donald P. Gray, previously mining engineer, has been promoted to production engineer at the Jackpile mine of the Anaconda Co.

Edward P. Rieder, Jr., has been promoted to Silver Bay Division industrial engineer, Reserve Mining Co. Rieder joined Reserve as a clerk in 1953 and in the following year he became a cost analyst in the industrial engineering department at Babbitt, Minn. In 1955 he was transferred to Silver Bay in the same capacity and in 1956 advanced to industrial engineer. Rieder will be in charge of the Silver Bay Division industrial engineering department.

Charles B. Tillson, Jr., has been appointed manager—raw materials (coal), of Crucible Steel Company of America. In his new position, he will provide planning, analysis, coordination, and will establish policy over the company's coal activities. Tillson, formerly assistant manager—Fuel Division, joined Crucible in 1952 as assistant superintendent at the company's coal mine at Crucible, Pa. He was appointed superintendent of the mine in 1953 and general superintendent in 1955. He was named assistant manager of the Fuel Division in 1958. Before coming to Crucible, Tillson spent 15 years with Bethlehem Mines Corp.

Robert L. Cranmer has succeeded **Clark L. Wilson** as vice president of New Park Mining Co., and has also become assistant general manager. Wilson is chairman of the Emergency Lead-Zinc Committee.

John W. Chandler has been appointed manager of the Mining Department of the Mining & Exploration Division, American Metal Climax, Inc. He succeeds **C. A. R. Lambly** who recently resigned to become president of Trout Mining Co.

Martin C. Dwyer has become affiliated with the American Mining Congress, where he will be active in the important work of developing the conventions and expositions of the organization and as assistant advertising manager of Mining Congress Journal.

Dwyer comes to the AMC after having been associated with the National Retail Lumber Dealers Association as its exposition director since 1955. For seven years prior to that time, he was manager of the Cleveland Convention and Trade Show Bureau, Inc., and earlier had edited two monthly publications for the Advertising Department of General Electric Co. During World War II he served for four years as a pilot with the U. S. Navy.

Weston G. Thomas has resigned as executive vice president of American Metal Climax, Inc.

William A. Barringer has been elected to the presidency of the Carbon Fuel Sales Co., and **L. Newton Thomas** was elevated to board chairman. Barringer joins Carbon Fuel after serving for over two years as vice president of sales for North American Coal Corp. Previously, he was general sales manager for Island Creek Coal Sales Co.

Frank W. Chambers, executive vice president of Strategic Minerals Corp., recently succeeded **John C. Udd** as president; Udd becomes chairman. Before joining Strategic Minerals late last year, Chambers had been director of engineering for Kennecott Copper Corp. for nine years.

Oscar W. Bilharz has been appointed director of the Office of Minerals Mobilization, Department of the Interior. He had been acting director since the retirement of **Spencer S. Shannon** in December 1959. Bilharz came out of retirement in June 1956 to serve as a consultant to OMM and shortly thereafter was appointed coordinator for base metals, a position he held until being designated acting director. He is a former president of O. M. Bilharz Co., Inc., as well as of the Tri-State Zinc & Lead Producers Association.

W. D. Grabow was recently appointed assistant superintendent of mechanical maintenance, Silver Bay Division, Reserve Mining Co.

Guy T. McBride, Jr., has been elected a vice president of Texas Gulf Sulphur Co. McBride joined Texas Gulf in 1958 and a year later was named manager of the Research Department. Prior to 1958 he was a consultant to the company and associate professor of chemical engineering and dean of students at Rice Institute.

Recent organizational changes in the minerals division of Kerr-McGee Oil Industries, Inc., include naming **V. L. Mattson** as general manager, minerals; and **R. T. Zitting** as manager, mineral exploration and land. Mattson was formerly manager of mining and milling while Zitting was manager of mineral explorations. **Phil Ellsworth,** who had been district geologist at Golden, Colo., has been promoted to chief geologist, minerals.

Lewis E. Evans was sworn in as Secretary of Mines and Mineral Industries for the State of Pennsylvania June 13. Evans had been Acting Secretary since Joseph T. Kennedy resigned April 1 to become vice president of the United Mine Workers of America.

A. H. Truax has resigned as president of the Illinois Coal Operators Association, and **F. F. Kolbe** has resigned as a director. **Ted L. Kelce,** vice president, Peabody Coal Co., succeeded Truax as president and **John M. Morris,** new president of The United Electric Coal Co., replaced Kolbe as a director.

Joseph T. Hall, president of Callahan Mining Corp., has been appointed a director of the Bunker Hill Co. Hall has more than 25 years of mining experience which began with San Juan Metals Corp. in 1934. He joined Sunshine Mining Corp. the following year, and in 1936 went to work for Callahan. He was elected president of Callahan in 1945.

Glenn M. Hatch has been elected president of Hercules Cement Co., an operating division of American Cement Corp. Hatch, who has been active in the cement industry for the past 32 years, was formerly vice president of sales for Hercules. He replaces **James P. Giles** who was recently elected executive vice president of American.

E. P. Pfleider, professor and chief of the Division of Mineral Engineering, University of Minnesota, has replaced **S. R. B. Cooke,** Chief of the Division of Metallurgical Engineering, as head of the School of Mines and Metallurgy in the Institute of Technology. Division chiefs of the department are periodically rotated to serve as department head. Pfleider, who has taught at Minnesota since 1948, is also active as a consultant on mine design.

OBITUARIES

Murl H. Gidel, 71, retired assistant chief geologist for North American Properties with the Anaconda Co., died in Butte, Mont., March 18.

Mr. Gidel joined Anaconda in 1912. He was employed continuously at its mines in western states and on examinations of numerous properties in North America as well as at the holdings of Silesian-American Corp. in Poland until his retirement in 1958.

NEWS and views

Kennecott's New Refinery Formally Dedicated

Kennecott Refining Corporation's $30,000,000 electrolytic copper refinery was recently dedicated at Hawkins Point in Anne Arundel County just south of Baltimore, Md. The new refinery, recently named one of the "Top Ten Plants of 1960" in the United States, operates as a wholly-owned subsidiary of Kennecott Copper Corp.

The plant is currently processing approximately 10,000 tons of high-purity copper per month from the company's copper mines in Arizona, Nevada, New Mexico, Utah and Chile. Its designed capacity is 16,500 tons per month.

The most modern innovations have been incorporated into the construction and design of the refinery to make it a highly efficient production operation.

NCPC Conducts Press Tour of Midwestern Coal Industry

The National Coal Policy Conference, Inc., conducted a tour of modern coal mining operations in three midwestern states, June 12–14. By means of planes and bus, the party of newsmen and a number of coal industry leaders visited highly mechanized stripping and underground mines in southern Illinois, southern Indiana and western Kentucky. Highlighting the trip were such things as a 65-yd shovel, the Kolbe wheel excavator, an eight tpm continuous mining machine, a new 800 tph preparation plant, and rail and river transportation operations. The trip clearly demonstrated the modern automation which has made it possible for coal to hold the production price line steady for the past ten years.

Operations visited by the group included Peabody Coal Company's Lynnville mine: Wright mine of Boonville Collieries Corp., Yankeetown Dock, owned jointly by Peabody Coal Co. and Ayrshire Collieries Corp.; Paradise mine of Pittsburg & Midway Coal Mining Co.; Peabody's River Queen mine; East Diamond mine of West Kentucky Coal Co.; Burning Star No. 2 mine of Truax-Traer Coal Co.; Fidelity mine of United Electric Coal Cos., and Old Ben Coal Corporation's Mine No. 21.

Cerro de Pasco Gains Control of Rio Blanco

Cerro de Pasco Corp. has acquired control of Rio Blanco Copper Corp., Ltd. Rio's principal asset is the ownership of virtually all of the capital stock of Compania Minera Rio Blanco Limitada, a Chilean company. Limitada, in turn, owns the mining claims near Santiago, Chile, on which Cerro has been exploring and preliminarily developing a copper ore body.

The Rio Blanco mining claims are some 31 miles northeast of Santiago. The property contains a large porphyry copper deposit.

Spencer Acquires Assets of P&M Coal Mining Company

The board of directors of Spencer Chemical Co. has approved an agreement with the Pittsburg & Midway Coal Mining Co. under which Spencer will acquire all of the assets of Pittsburg & Midway in exchange for common stock. The board of directors of Pittsburg & Midway approved the agreement at a meeting May 16. Spencer stockholders approved the merger June 30.

Pittsburg & Midway is an established coal producer in the Midwest, with mines in Kentucky, Kansas, Missouri, Colorado and Arkansas. At the close of its fiscal year ending March 31, 1960, net assets of Pittsburg & Midway were approximately $20,000,000. During the year it mined and sold in excess of 4,000,000 tons of coal, producing sales in excess of $16,000,000 and net income of about $1,750,000.

Spencer plans to continue the coal operations of Pittsburg & Midway as a wholly-owned subsidiary and contemplates no changes.

Soviet Engineers Develop New Equipment

A non-sparking electric locomotive has reportedly been developed by Soviet engineers. Electric energy is transferred from an insulated high-voltage cable to the locomotive by induction. The efficiency of the locomotive is said to be about 25 percent. With 42 tons of payload, the induction locomotive allegedly develops a speed of 5.6 mph on difficult track.

The Russians have also announced a lightweight miner's lamp. Developed by engineers in the Donets coal basin, the equipment weighs less than 21 oz and the efficiency is given as ten ampere hours. The accumulator, which can be carried conveniently in a miner's pocket, needs to be charged only once a week despite the small volume of the electrolyte.

Minerals & Chemicals Considers Merger

Directors of Minerals & Chemicals Corp. of America, Philipp Brothers, Inc., and Philipp Brothers Ore Corp. will recommend to their stockholders a merger of the three companies. The merged corporation would be known as Minerals & Chemicals—Philipp Brothers, Inc.

Philipp Brothers, and its subsidiary, Philipp Brothers Ore, are leading importers, exporters, processors and merchants in ferrous and nonferrous ores, metals and minerals. Foreign operations are conducted in Europe, the Near and Far East, South America, Australia and Africa.

Minerals & Chemicals is a major producer and processor of kaolin, attapulgite, activated bauxite and limestone products. The company maintains mines and plants in Arkansas, Florida, Georgia, Michigan, Ohio and Virginia.

Two New Kilns Replace 11 Coke-Fired Kilns

The Blair Limestone Division of Jones & Laughlin Steel Corp. has put into operation two new gas-fired limestone kilns which will double capacity for producing burned lime and improve the quality of the lime. They replaced 11 coke-fired kilns which had been in operation since 1911.

The two new kilns have a yearly rated capacity of 72,000 net tons of burned lime for J&L's steelmaking furnaces at Pittsburgh and Aliquippa, Pa.

Use of the gas-fired type of kiln results in a marked decrease—75 to 80 percent—in the amount of sulphur in the burned lime, thereby increasing efficiency in steelmaking furnaces.

ALSO . . .

New York Mining & Manufacturing Co. is planning a multimillion dollar coke manufacturing plant near Calvert City, Ky. The coal, which will come from eastern Kentucky and West Virginia coal fields, will be shipped to the new plant by barge, down the Ohio River and up the Tennessee to Kentucky Lake and the new facility. Construction will start as soon as contracts can be awarded and the project is expected to be completed by January 1, 1961. National Carbide Company's Calvert City plant will be the new coke plant's principal customer.

Charles M. Brinckerhoff, president of the Anaconda Co., recently told the New York Society of Security Analysts that current studies for future operating improvement in Chile include a 7500 tons-per-month copper refinery at Chanaral. He said that the construction of the new refinery depended on satisfactory conditions being granted by the Chilean government. Also under study for possible development is a 5000 tpd open pit near Anaconda's new El Salvador mine.

Greenwood Mining Corp. has announced that a modern anthracite preparation plant is to be constructed in Panther Valley, Pa., near the site of the former Tamaqua Colliery. Coal produced from the properties of Lehigh Coal & Navigation Co. will be prepared here, the output to be marketed exclusively by Lehigh Navigation-Dodson Co. Construction of the new plant is to begin immediately, and it will be in operation later this summer.

Ground has been broken for new breaking, screening, and cooling facilities for the sinter plant at the New York Ore Division of Jones & Laughlin Steel Corp. Facilities include a vertical shaft stationary cooler — the first of this type to be installed in the United States. Capacity of the new unit will be 3800 gross tons of product per day. The new equipment will enable the company to screen the fine sinter from the coarse, thereby providing a high-quality sinter and a better blast furnace burden.

The Third Quinquennial Alumni Reunion of the Minnesota School of Mines and Metallurgy, Institute of Technology, will be held October 7–8. Reservations for tickets and hotels may be made by contacting E. P. Pfleider, Mines and Metallurgy, University of Minnesota, Minneapolis 14, Minn.

The West German Association of Coal Importers in its annual report for 1959 calls for an end to restrictions on the import of coal into West Germany. Noting that these restrictions have not helped the coal industry as much as they have aided other sources of energy, the report says they should be abolished.

Texas Gulf Sulphur Co. will close its huge shipping operations in Galveston, Texas, this fall and shift them to Beaumont where it recently completed a new $3,000,000 dry sulphur dock.

Planning to tap 10,000 acres of Pittsburgh No. 8 coal, Hanna Coal Co. has announced it will open a new mine near Cadiz, Ohio, after the Glen Castle mine is worked out during the next few years. The date for commencing construction of the new mine has not been decided.

Aluminum Company of America has acquired a fourth major source of bauxite by exercising an option covering mining rights on 30,000 acres of bauxite bearing lands in Jamaica. Alcoa optioned the area ten months ago by agreement with the Jamaican government and Caribex, Ltd., a wholly-owned Canadian subsidiary of American Metal Climax, Inc. The construction and development program calls for production to begin by June 1, 1963. The ore will then be shipped to Alcoa's Point Comfort, Texas, refining plant for the extraction of alumina.

Peabody Wright Corp., formed in January by Peabody Coal Co. and Curtiss-Wright Corp. to explore new bituminous coal-based products, plans to complete by next fall its proposed coal tar pavement binder plant. A small commercial plant will be located at Columbia, Tenn.

The 23rd Annual ASME–AIME Joint Solid Fuels Conference will be held October 24–25 at the Daniel Boone Hotel, Charleston, W. Va. Theme of the conference will be "Economics in the Production and Utilization of Coal." Julian E. Tobey, consultant, Cincinnati, Ohio, is chairman of the planning committee.

Black mica can be turned into a food valuable in battling overweight and radioactive contamination, according to Dr. Milton Parker, food engineering chairman at the Illinois Institute of Technology. He told the annual research meeting of the Food Container Institute that tests on animals indicated black mica causes radioactive contaminants in food to be eliminated through the intestines, cutting their passage into body tissues. In addition, the mineral might contribute significantly in reducing calories for the control of obesity.

Foote Mineral Co. of Exton, Pa., plans to build a multi-million dollar plant at New Johnsonville, Tenn. The company has acquired a 670-acre tract south of New Johnsonville along the Tennessee River where it will produce electrolytic manganese. Production is expected to start next year.

EDITORIALS *(Continued from page 23)*

courts, and held that a sewer pipe producer could compute depletion not on the basis of the finished product but only on the value of the raw clay. The Supreme Court's decision leaves unanswered some questions as to past years, which may require further litigation. However, it is now clear that for some branches of the mining industry the new law defining "mining" is a blessing in disguise—it will eliminate any possibility that for future years the Treasury might, under the Supreme Court's decision, try to disallow some processes which are specifically allowed in the new definition of "mining."

In the long run the mining industry will at least benefit from the fact that this vexing controversy is now, for the most part, put to rest. Depletion is no longer subject to attack on the grounds that it is merely a subsidy; as the Supreme Court stated in the *Cannelton* decision, "Depletion, as we have said, is an allowance for the exhaustion of capital assets. It is not a subsidy to manufacturers or the high-cost mine operator." The mining industry can fully justify the percentage depletion concept—but only if, as the AMC Tax Committee advocated, this concept is "continued on a sound and reasonable basis."

Iron workers place the first and heaviest girder for a new pellet plant at Bethlehem Steel Company's Grace mine, near Morgantown, Pa. Bethlehem is fabricating and erecting 5800 tons of structural steel for the plant. To be completed about the end of the year, it will be the final major production facility for the Grace mine, the Nation's newest and deepest underground iron ore producer. The mine is expected to be in full operation by 1962.

NEWS and views

Western

Contemplate 800 to 1000 TPD Uranium Mill

Three western mining companies have joined forces for the mining and milling of uranium ore in the Shirley Basin district of Wyoming. The companies, Hidden Splendor Mining Co., Federal Resources Corp., and Gas Hills Uranium Co., have submitted a request to the Atomic Energy Commission for a license to construct a uranium processing mill in Shirley Basin, about 60 miles south of Casper, Wyo.

The companies control about 1500 mining claims in this district. More than 300,000 ft of drilling has been completed and although drill holes are relatively wide spaced, exploration to date indicates several million tons of ore, most of which occurs in deposits that are shallow in depth. Officials believe that mining costs will be unusually low and they are studying advanced mining methods with equipment not used before in mining of uranium. The companies advised the AEC that they were proceeding with preliminary design of a mill to process between 800 and 1000 tpd of ore. This would result in annual production of about 1,000,000 lb of uranium concentrate. There are no uranium mills in the Shirley Basin area.

Go-Ahead Given on Atlantic City Project

The Columbia-Geneva Steel Division of U. S. Steel Corp. has announced that work will begin immediately on construction of an iron ore mining and beneficiation facility in Fremont County, Wyo., about 26 miles south of Lander. After completion late in 1962 the extensive ore mining, concentrating and pelletizing operation will supply pelletized iron ore to Columbia-Geneva Steel's integrated steel plant near Provo, Utah. The ore will supplement Geneva's present source of iron ore from mines near Cedar City, Utah, which will continue in operation.

Known as the "Atlantic City Project," the mine will be 8300 ft above sea level in Wyoming's rugged Wind River Mountains. It is destined to become the highest, large-scale open pit iron mining operation in the United States. Major units slated for construction include crushing and screening facilities, an ore concentrating plant, a pelletizing plant, an extensive water storage and handling system, and loading and shipping facilities. A key feature of the operations will be a tailing basin for waste disposal and recovery of clean water.

Conventional open pit methods will be used to mine the ore, which contains about 30 percent iron. Next the ore will be crushed, then magnetically concentrated to about 60 percent iron; after which it will be pelletized for Geneva's blast furnaces. Pelletized ore will be shipped from Atlantic City to Provo via a new railroad spur to the Union Pacific line at Winton Junction, which serves the coal mining district near Rock Springs, Wyo. To handle the Atlantic City pellets, some modifications or additions will be made to iron ore storage and conveying facilities at the Geneva Works.

Coal to Power New Arizona Utility Plant

A major breakthrough for coal was signalled by the recent announcement of a long-term agreement between Arizona Public Service Co., Phoenix, Ariz., and Pittsburg & Midway Coal Mining Co., Pittsburg, Kan., under which P & M will supply 380,000 tons of coal annually for a new 110,000 kw steam electric generating station to be built near Joseph City, Ariz. This is the first large coal-burning electric generating plant to be constructed in Arizona. Pittsburg & Midway will supply the coal from a new million ton open pit mine just west of Gallup, N. M. The mine is scheduled to be in production by January, 1962 and the power plant will go on line a few months later. The agreement calls for the dedication by P & M of coal reserves for 35 years, assuring Arizona Public Service of a long-term economical fuel supply. The coal will be moved approximately 100 miles by rail from mine to power plant.

Safety Record Honored

American Chrome Co. of Nye, Mont., a subsidiary of the Goldfield Consolidated Mines Co., recently reported that it had completed one full year of underground operations without a lost time accident. In this period, 21,395 man-shifts were worked for 175,160 man-hours of exposure. The mine has received the Award of Honor from the National Safety Council and the Certificate of Honor from the Joseph A. Holmes Safety Association. American Chrome is the only underground metal mine in the Northwest to receive the Holmes Award. The company's achievement is attributed to the "fine cooperation between members of the local union and management."

Major Exploration Planned

Lead-zinc-silver properties in Nevada's Eureka mining district will be

the site of renewed exploration by the recently organized Ruby Hill Mining Co. Ruby Hill was formed by Richmond-Eureka, Cyprus Mines Corp., Newmont Mining Corp. and Eureka Corp., Ltd. as equal participants in the venture. Hecla Mining Co. will participate through a subsequent agreement with Eureka. The new company, acting as operator for the five parties, is planning expenditures of $1,000,000 to carry out a work program aimed at developing additional ore at properties of Richmond-Eureka, which is controlled by U. S. Smelting Refining & Mining Co. The principals will, following the initial expenditure, have options to purchase $9,000,000 in shares of Ruby Hill. These funds would be available for further exploration, development and mining.

ALSO . . .

A significant deposit of a new beryllium ore is reported to have been discovered in the Topaz Mountain area of Utah, about 150 miles from Salt Lake City. Officials of Vitro Minerals Corp., one of the largest claim holders in the Topaz Mountain area, said the new ore is found in disseminated non-pegmatitic deposits, much of it lying close to the surface where it can be mined by open-pit methods. Studies by the company indicate that the ore is apparently amenable to conventional hydro-metallurgical processing. Laboratory studies to prove out the economics of processing the mineral are being conducted at Vitro Chemical Company's uranium plant at Salt Lake City.

Production of uranium ore at the Mary No. 1 mine of Entrada Corp. in McKinley County, N. M., is being increased as development work nears completion. The operating rate is to be raised 5000 tons per month until the mine is producing between 28,000 and 33,000 tons per month before the end of the year. The company has been bringing the mine into production since completion of a three-compartment shaft in July 1959. Subsequent development work permitted mining of about 19,000 tons of uranium ore before the end of 1959.

Stockholders of Mascot Mines, Inc., and Pine Creek Lead-Zinc Mining Co. have been asked to approve a merger of the two companies, whose major holdings are in the Pine Creek District of Idaho.

An iron ore beneficiating plant will be built at the Iron Springs mine of Utah Construction & Mining Co. near Cedar City, Utah. Utah Construction, which up to the present has only crushed and screened its ores prior to shipment to the Geneva Works of U. S. Steel Corp., will build an addition to its present facility for magnetic upgrading of ores to about 52 to 54 percent iron. The beneficiation unit is expected to be in operation next spring.

A "Directory of Known Mining Enterprises, 1959," Bulletin 14, listing 264 metallic and nonmetallic mining properties, including 67 active coal mines, is available at no charge from the Montana Bureau of Mines & Geology, Montana School of Mines, Butte. In addition to the list of mines, a section of the publication is given over to production data and describes recent developments in 28 metallic and nonmetallic mineral commodities.

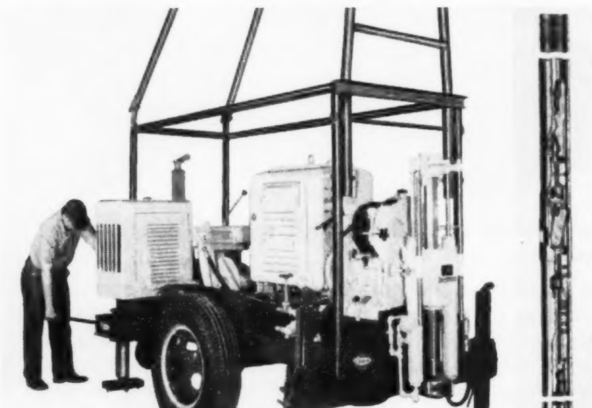
Dawn Mining Co. will purchase 320 acres of uranium mining leases on the Spokane (Wash.) Indian Reservation from Silver Buckle Mining Co. for $1,000,000. Silver Buckle acquired the leases from Northwest Uranium Mines, Inc., and until recently had been negotiating with Dawn and the Atomic Energy Commission for a uranium ore allotment at the Dawn mill for the period through 1966. New Park Mining Co. is one of the largest stockholders in Silver Buckle, while Dawn is owned by Newmont Mining Corp. and Midnite Mines, Inc.

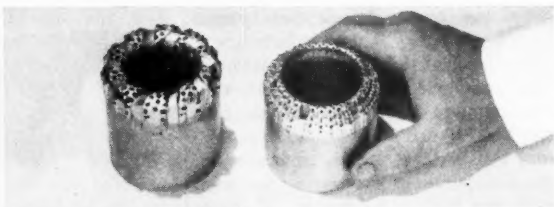
An abandoned lignite mine near Denver, Colo., is being used as a storage area for natural gas in storage tests being conducted by Public Service Company of Colorado. Providing a readily available source of gas during prolonged sub-zero weather, the storage project is said to be the first of its kind.

New exploration for lead and zinc in the Park City mining district of Utah will be conducted as a result of a recent Office of Minerals Exploration loan to United Park City Mines, Inc. OME has authorized the company to spend about $166,000 for exploration, of which one-half will be provided by the Government. In a related development, OME has proposed to grant Keystone Mining Co. a loan for its participation with United Park in the Park City exploration. Keystone would be authorized to spend about $112,000 on the project of which the Government would pay one-half.

Nickel and cobalt will be mined in Del Norte County, Calif., and adjoining Josephine County, Ore., according to plans of Chemical & Metallurgical Enterprises, Inc. The company, which reportedly controls large deposits of nickel-cobalt, proposes to build a "leaching processor" and smelter on the California site for recovery of nickel, cobalt, chromium and magnesium by a new extraction process.

Plans for two proposed western steel mills that will utilize copper smelter slags have been revised. Webb & Knapp, Inc., who had announced earlier that they would erect 100,000 ton per year steel mills at Clarkdale, Ariz. and Anaconda, Mont., has indicated that planned capacity is being upped to 350,000 tons.





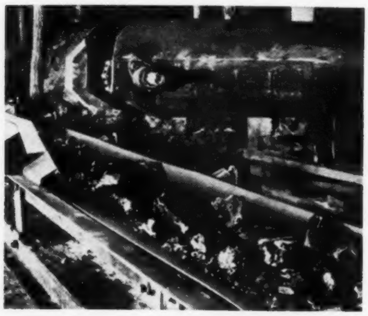
Another aluminum reduction facility is proposed for the Pacific Northwest. United Pacific Aluminum Corp., a West Coast fabricator, has taken an option on a 300-acre site near Longview, Wash., where it would erect two potlines, one of which would be ready for production late next year. The company's plans depend upon obtaining power for at least one potline from Bonneville Power Administration. The capacity of the proposed facility was not disclosed.

A radiation detection device is being used in connection with recovery of mill water from tailings at Kennecott Copper Corporation's Hayden, Ariz., operations. Faced with a water deficit with about 50 percent increase in production, the company installed the device to regulate the flow of tailing-bearing water into a thickening "pool" according to the density of solids accumulating at the pool's center discharge pipe in which there is contained radioactive isotopes. The detection unit automatically adjusts in-flow to allow suspended material sufficient time to settle out and for clear water to be recovered.

A contract between Bethlehem Copper Corp., Ltd., and Sumitomo Metal Mining Co., Ltd., of Japan could lead to development of Bethlehem's Highland Valley, B. C., copper prospect. Sumitomo recently contracted with Bethlehem to provide $350,000 for continued exploratory work, and to make a production decision on the property by the end of February 1961. Provisions of the agreement would require erection of a 3000 tpd mill, to be increased to 5000 tpd within 24 months after production begins, and commit the Japanese to take full mine output for ten years.

manufacturers forum

A COAL BELT, called "Coalmover" by its manufacturer, Manhattan Rubber Div., Raybestos-Manhattan, Inc., Passaic, N. J., is said to have solid edges which will not fray or fan out even under toughest abrasion. Another advantage claimed is an excep-



tional pulley grip which permits operation at lower tension without slip, while low stretch characteristics reportedly insure a minimum of take up adjustments. The equipment has been certified by the Bureau of Mines with a Fire-Resistant acceptance designation.

A FRONT-END WHEEL LOADER known as TL-12 has been announced by Allis-Chalmers, Milwaukee 1, Wis. The vehicle has a carrying capacity of 4000 lb, a static lifting capacity of 9500 lb, and incorporates the power

reversing Tractomatic transmission. A lever on the steering column controls both forward and reverse movement without stopping the machine to clutch and shift gears. This lever hydraulically engages the two multiple disc, dry-type clutches—one for forward travel, the other for reverse. Four speeds forward are provided to 21.2 mph, and four reverse speeds to 27.9 mph. Reverse speeds are approximately 30 percent faster than forward speeds in the same gear, thus allegedly permitting a faster loading cycle without shifting to a higher gear to achieve the same effect. The TL-12 is available with either Allis Chalmers 77-hp gasoline or 76.5-hp diesel engines.

A MINE ROOF BOLT MAT, developed by Commercial Shearing and Stamping Co., Youngstown, Ohio, is employed specifically for prevention of rock spalling conditions. Said to be light, easy to handle and install, it was designed to improve safety in

mining and excavating and to reduce the number of roof bolts formerly required and to provide support between roof bolts. The mat is 13 in. wide, 108 in. long, and 7½ in. wide between corrugations to allow full contact with a roof bolt plate. Two in. diam holes are spaced seven in. apart on the mat thereby providing maximum utility in spacing roof bolts. The mat is said to be flexible enough to conform to the roughest contours of the mine or excavation.

A CAR SHAKER said to be completely safe for one-man operation is being produced by Syntron Co., 703 Lexington Ave., Homer City, Pa. It can be mounted anywhere along the length of the car by means of a jib crane or fork lift. There are no

chains or rods to tighten, no need for operator to get in, on, or under the car. The rotary vibrator car shaker is said to transmit powerful vibrations throughout the car to loosen and shake the compacted material through open hopper gates. The self-contained rotary vibrator produces 900 vibrations per minute, operating from a 220 or 440 volt, 3-phase, 60 cycle a-c supply. The vibrator is mounted in a sturdy steel frame designed to hook over light or heavy flanged car sides. A balancing counterweight simplifies mounting and contributes to the efficient vibrating action.

A SPIRAL WIRE REINFORCED FLEXIBLE VENTILATION TUBING called "MineDuct" has just been announced by American Brattice Cloth Corp., Warsaw, Ind. Claimed advantages are flame resistance, airtightness, strength, lightness of weight, and retractability. The tubing, colored yellow for added visibility and underground safety, incorporates a wire covered on both the inside and outside of the tube as it is wrapped within the spiral, and it is said to perform within a temperature range of minus 40° to plus 250° F.

—ANNOUNCEMENTS—

Herbert G. (Pat) Dillon has been named to fill the new position of assistant to the president at **Lee-Norse Co.,** Charleroi, Pa. Before joining Lee-Norse, Dillon was first vice president of **McKiernan-Terry Corp.** at Harrison, N. J., and before that was associted with **Heyl & Patterson, Inc.,** Pittsburgh, Pa.

Anaconda Wire and Cable Co. has announced the appointment of **Steve Bunish** as manager-portable cable sales. With the company since 1942, he has spent much of his time on research and development of mining and portable cable. An author of several technical bulletins in this field, Bunish is active on the Committee on Underground Power of the American Mining Congress.

Herbert G. Torpey has been appointed district sales manager for **Joy Mfg. Co's.,** Mining and Construction Division, San Francisco office, replacing **L. C. Rhodes** who has been granted an extended leave of absence. Torpey, associated with the San Francisco office since 1953, will manage sales and service of Joy's line of equipment for metal and hardrock mining and heavy construction industries in California, Hawaii, Alaska, and western parts of Washington, Oregon and Nevada.

American Cyanamid Co. has appointed **L. V. Clark,** manager of its New Castle, Pa., explosives plant for the past 13 years to a new post, director of explosives research and development. He will still operate from New Castle but will now devote his attention to explosives research and development projects. Clark has been active in the explosives field since 1927, and he has been with American Cyanamid since 1936.

D. W. Stevens

Edward L. Mills has been appointed by **Link-Belt Co.,** as district manager at Huntington, W. Va., succeeding **David W. Stevens,** who retired after 48 years service to the company. Mills is being succeeded as Duluth, Minn., district manager by **Earl W. Habberstad.** Stevens first joined Link-Belt in the Philadelphia engineering department in 1912. Mills began his career with the company in 1948 upon graduation from Purdue, and Habberstad has been with the company the same length of time, beginning as a draftsman in the Minneapolis plant.

E. L. Mills

E. W. Habberstad

A. G. Gilbert formerly general sales manager of the **Wilmont Engineering Co.** has joined the Sales Engineering forces of **McNally Pittsburg Manufacturing Corp.,** specializing in fine coal treatment, flotation, water clarification and cyclonic classification. Gilbert will be active in the Pennsylvania, West Virginia, Virginia and Eastern Kentucky coal fields.

Reichdrill Div., Chicago Pneumatic Tool Co., announces new locations for its engineering and manufacturing facilities and for the sales office. The former is now located at Orchard and Howard Sts., Venango County, Franklin, Pa., and the latter at 1442 Beech St., Terre Haute, Ind.

Ingersoll-Rand Co. has announced the promotion of **Joseph A. Wiendl** from assistant general manager of sales to general manager of sales. With the company since 1941, Wiendl has been active in the Rock Drill Dept. in the development and sales of heavy rock drill products, and had been manager of that department before going into general company sales.

Peter Ambrosiani has been appointed general sales manager of **Wilcox Mfg. Co.** Joining Wilcox after 17 years with **Jeffrey Mfg. Co.,** Ambrosiani will direct the sales of Wilcox continuous mining machines.

Heyl & Patterson, Inc., has announced the appointment of **William J. Crawford** as Production Manager. Crawford has been associated with Heyl & Patterson in various supervisory capacities since 1944.

Schroeder Brothers Corp., McKees Rocks, Pa., has named **William A. Simonds** a sales engineer on the company's hydraulic and mining equipment. Formerly with **Standard Oil of Ohio,** Simonds has had extensive experience in petroleum sales.

National Mine Service Co. has named **William D. Menzie** sales manager of the Distributor Products Division with headquarters in the company's executive offices in Pittsburgh. He had been district manager of the Whiteman Division in Indiana, Pa.

S. O. Bringhurst, a 30-year employe of **Mine and Smelter Supply Co.,** has been appointed manager of the Salt Lake City Branch. He succeeds **William J. Berryman** who is retiring after 43 years service to the company.

Ronald R. Blevins, formerly manager of **Joy Mfg. Co.'s.,** Norton, Va., warehouse, has been appointed a sales engineer for Joy coal machinery with headquarters at the company's district office in Huntington, W. Va.

(Catalogs & Bulletins next page)

CATALOGS & BULLETINS

WELDING HANDBOOK. *American Welding Society, 33 West 39th St., New York 18, N. Y.* The publication of the Third Section of the Fourth Edition of the Welding Handbook has been announced. Comprehensively indexed and illustrated and containing many tables, the publication includes both old and new developments in the field, including among the latter such topics as ultrasonic welding. A descriptive leaflet is available free of charge and the Handbook can be purchased at a list price of $9.00 per volume.

INDUSTRIAL CAPACITORS. *Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.* Booklet B-7642 describes use of industrial capacitors to reduce power costs and increase system capacity. Subjects include a discussion of power factors, benefits of capacitors, selection of capacitors and where and how to apply them.

POWER STEERING SYSTEMS. *Vickers, Incorporated, Div. of Sperry Rand Corp., Administrative and Engineering Center, Dept. 1400, Detroit 32, Mich.* Charts, drawings and tables are used in Bulletin No. M-5110 to describe the line of production-built power steering components which reportedly can be combined to suit virtually any steering axle load requirement. The interchangeability of various components, plus the wide capacity range of pumps, servo valve and cylinders, permits maximum flexibility in providing remote or integral steering-linkage type systems to suit vehicle power requirements and mounting space limitations, according to the brochure.

REVOLVING SCRUBBERS. *McLanahan & Stone Corp., Hollidaysburg, Pa.* Bulletin HDS-70 describes the line of revolving scrubbers for cleaning sand, gravel, crushed stone and various ores. Designed to handle product sizes up to eight in., the H-D scrubbers are made in three sizes: 6 by 12 ft for 60–120 tph capacities, 7 by 14 ft for 90–180 tph capacities, and 8 by 14 ft for 125–250 tph capacities.

CABLE SPLICING. *The Okonite Co., Passaic, N. J.* Now available without charge are a 30-page illustrated booklet, "The Fundamentals of Splicing and Terminating Rubber-Neoprene Cables", and two 16mm Kodachrome colored films, entitled "Spliced for Life". The booklet, Bulletin 1134, contains step-by-step information on splicing and terminating both shielded and unshielded cables. Also included are tape selector and quantity estimating charts, and a purchase planning aid sheet. The films include scenes showing preparation of cable ends, installation of soldered connectors or compression lugs and build-up of the splice. Print No. 1 covers unshielded cables for use up to 5000 volts and No. 2 the shielded variety for higher voltages.

TRACK CLEANER. *American Mine Door Co., 2037 Dueber Ave., S.W., Canton 6, Ohio.* Complete with illustrations, specifications and descriptive text, the brochure explains the principles of operation, construction and installation of the Models 30 and 60 "Canton" track cleaner.

GAS TURBINE POWER. *General Electric Co., Schenectady 5, N. Y.* Bulletin GEA-7083 introduces the company's family of 75 hp to 20,000 hp ultra-lightweight, compact gas turbines designed for a wide variety of applications including fluid and gas pumping, electric power generation, and marine and vehicular propulsion. Design features, performance and operating characteristics are described.

DUST FILTER. *Day Sales Co., 810 Third Ave., N.E., Minneapolis 13, Minn.* Bulletin G-30 describes how the "RJ" dust filter, claimed to be newly improved in design, filters and recovers dust with top efficiency from airstreams lightly or heavily loaded with extremely fine, coarse, abrasive or non-abrasive dusts. The unit has only three moving parts. Dimensions and specifications are outlined.

TRACTOR. *Caterpillar Tractor Co., Peoria, Ill.* Form 33550, "Caterpillar Presents the All New D4 Series C Tractor", describes the D4 Tractor that incorporates a new diesel engine and a lifetime lubricated undercarriage. The engine is listed with 65 hp at the flywheel and is said to have 25 percent more lugging ability. The company also emphasizes the high ground clearance of the vehicle, its traction and its ability to perform on soft footings that bog down wheel tractors.

SPIRAL CLASSIFIERS. *Mine and Smelter Supply Co., Denver 16, Colo.* Catalog No. 601 includes complete information on Akins Spiral Classifiers, describing principle of operation, construction details, capacities, drawings for general plant layout purposes, and detailed information on applications in open and closed circuit operation, sand preparation, iron ore concentration, solar salt washing, phosphate rock recovery, and washing glass sand. There is also information on Akins dense media separators.

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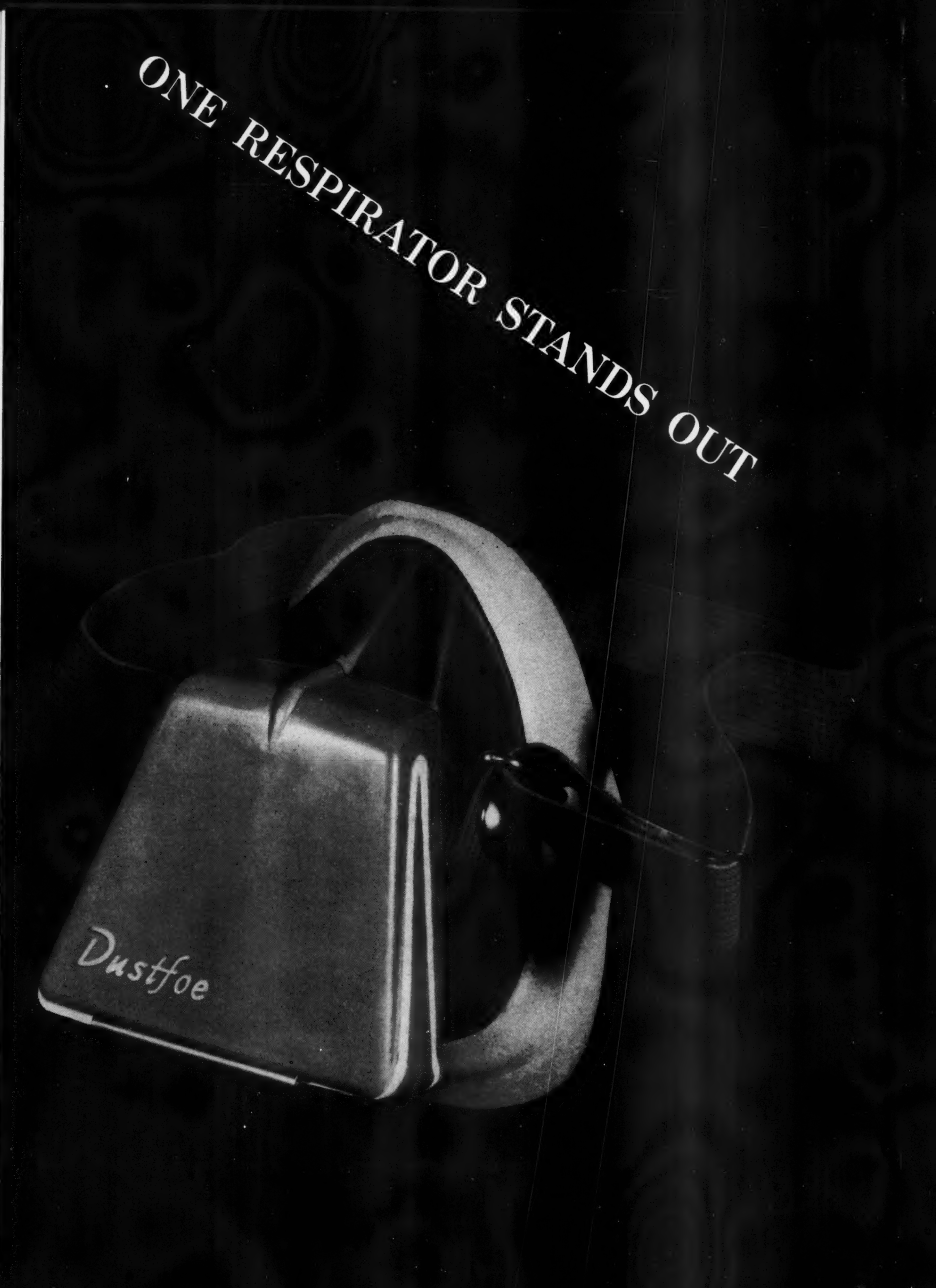
ONE RESPIRATOR STANDS OUT
Dustfoe